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MARCH 14, 1958

electronics

engineering edition

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IRE Program and Show Guide

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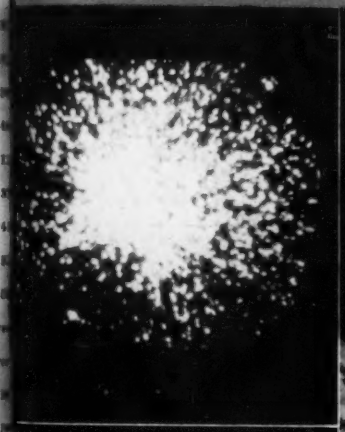

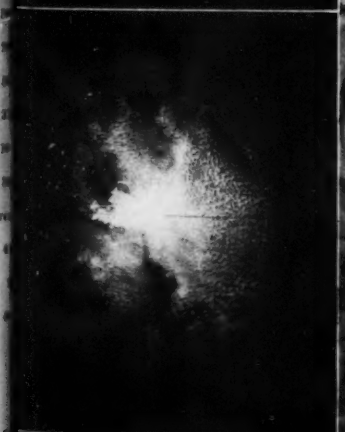

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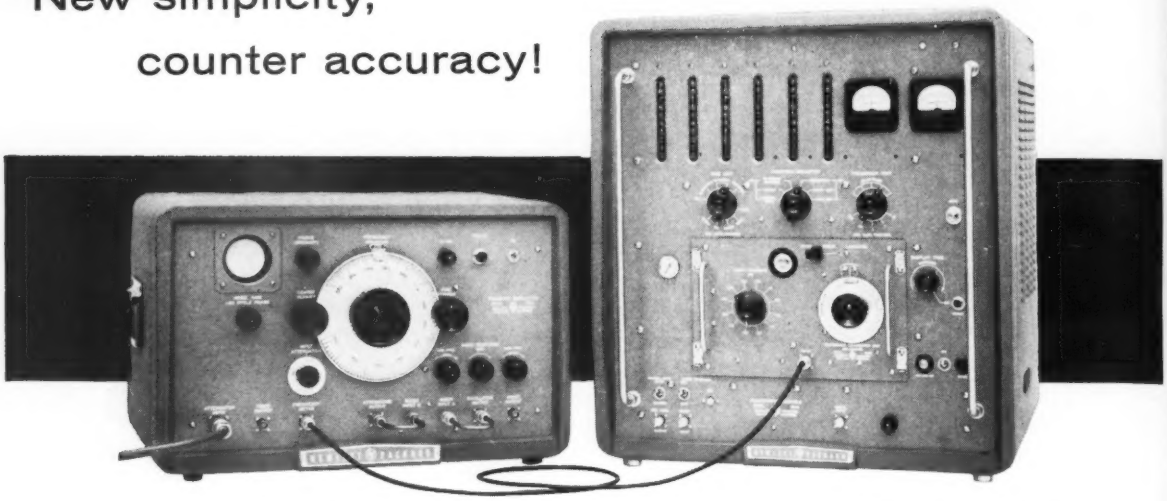
New simplicity, counter accuracy!



-hp- 540A Transfer Oscillator

-hp- 524B Electronic Counter

Measure frequency to 12 KMC on pulsed, AM, FM, CW and noisy circuits

Fast, convenient, simple set up

Just two *-hp-* instruments—Model 540A Transfer Oscillator and Model 524B Electronic Counter (with plug-ins) permit you to measure unknown frequency to 12 KMC with speed and accuracy.

Complex instrument arrangements and tedious trial-and-error work are eliminated. When approximate signal frequency is known, the 540A oscillator is merely tuned until one of its harmonics zero beats with the unknown. The multiplying factor is noted, and the 540A frequency measured precisely on the 524B Counter. The 524B reading, times the multiplying factor, is the unknown.

When the signal frequency is totally unknown, a simple calculation employing two or more harmonics determines the proper multiplying factor; the measurement is then made as before.

On clean CW signals accuracy is about 1/1,000,000; overall accuracy is better than 10 times that of the best microwave wavemeters.

Many different uses

The unique 540A/524B combination is particularly useful for swift CW and AM frequency determination, measuring center frequency or deviation range on FM signals, measuring frequency on high noise circuits and making high-accuracy measurements on pulsed signals.

Features—Model 540A Transfer Oscillator

Oscillator Fundamental Frequency Range 100 to 220 MC. Harmonic Frequency Range to 12 KMC. Stability better than 0.002% change per minute after warmup. Output 2 v into 50 ohms. Attenuator range 20 to 80 db, into 50 ohms, low SWR. Amplifier 40 db variable gain, 1 v output. Self-contained oscilloscope 100 cps to 200 KC, vertical deflection sensitivity 5 mv rms/inch at mixer output. Prices: *-hp-* 540A Transfer Oscillator, $615.00; *-hp-* 524B Electronic Counter, $2,150.00; *-hp-* 525B Frequency Converter Unit, $250.00.

For complete discussion and information, see your -hp- representative or write -hp- for Technical Data sheets and -hp- Journal, Volume 6, Number 12.

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electronics engineering edition

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electronics

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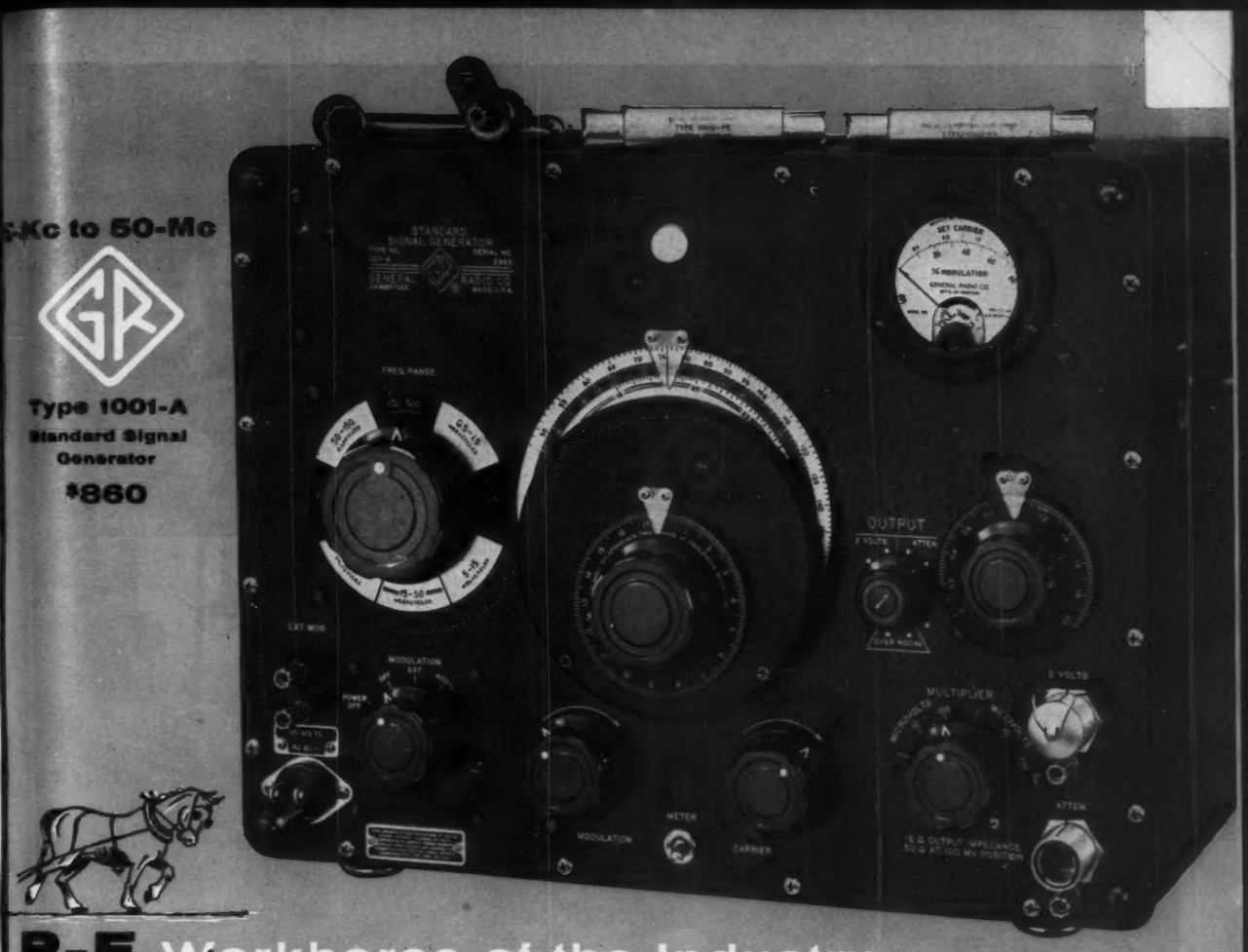

5-Kc to 50-Mc

GR

Type 1001-A
Standard Signal Generator
$860

R-F Workhorse of the Industry

This instrument's wide frequency range, excellent shielding, sturdy construction, and low cost make it one of the most popular Standard-Signal Generators available. Simplicity of design has resulted in a very high performance-to-cost ratio. Stability and low drift are assured by high-quality components, low power consumption, and stabilized power supply. Internal modulation is provided over a range of 0 to 80%.

Carrier Frequency Range: 5-kc to 50-Mc in eight direct-reading ranges.

Frequency Calibration: ±1% accuracy; logarithmic variation gives constant precision of setting over most of range.

Incremental Frequency Dial: Indicates frequency increments directly in percent.

Output Voltage: Attenuator Jack: 0.1 μv to 200 mv open circuit, continuously adjustable.
Second Panel Jack: 2-VOLTS to at least 15 Mc.

Output Impedance: Attenuator Jack: 10Ω except for highest attenuator position where impedance is 50Ω; 50Ω when 40Ω Series Unit is used. 25Ω at end of Terminated Cable.
2-VOLT Panel Jack: 300Ω.

Output Voltage Accuracy: Below 10 Mc: ±(6% + 0.1 μv) with output dial near full scale.
Above 10 Mc: ±(10% + 0.3 μv) near full scale.
At 2-VOLTS Jack: ±3% to 15 Mc.

Amplitude Modulation: Adjustable from zero to 80% — indicated on panel meter. Internal modulation is 400 cycles; external modulation from 20 cycles to 15 kc flat within ±1 db.

Incidental Frequency Modulation: No more than 30 to 300 ppm over most of range at 80% a-m; proportionately less at lower modulation percentages.

Carrier Noise Level: Corresponds to about 0.1% modulation.

Leakage: Stray fields at 1 Mc are less than 1 μv per meter, two feet from generator.

Servicing Feature: Oscillator section plugs into shielded compartment and is easily removed for operation outside the cabinet, making servicing particularly easy.

Accessories Supplied: Double-shielded coaxial cable with G-R 874 Connectors, 50Ω Termination Unit, 40Ω Series Unit, 874 Adaptor to banana plug, extra cable and panel connectors, spare fuses, and power cord.

Dimensions: 14⅜" x 20¼" x 10⁹⁄₁₆" **Net Weight:** 54 lbs.

IRE

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Booths 3302-3310

on display:

... **new Transfer-Function Meter** for complete investigation of basic transistor properties at vhf and uhf and measurement of other complex transfer functions.

... **VHF-UHF Dielectric Measuring Line** for accurate and simplified measurement of dielectric constant and loss of solid materials.

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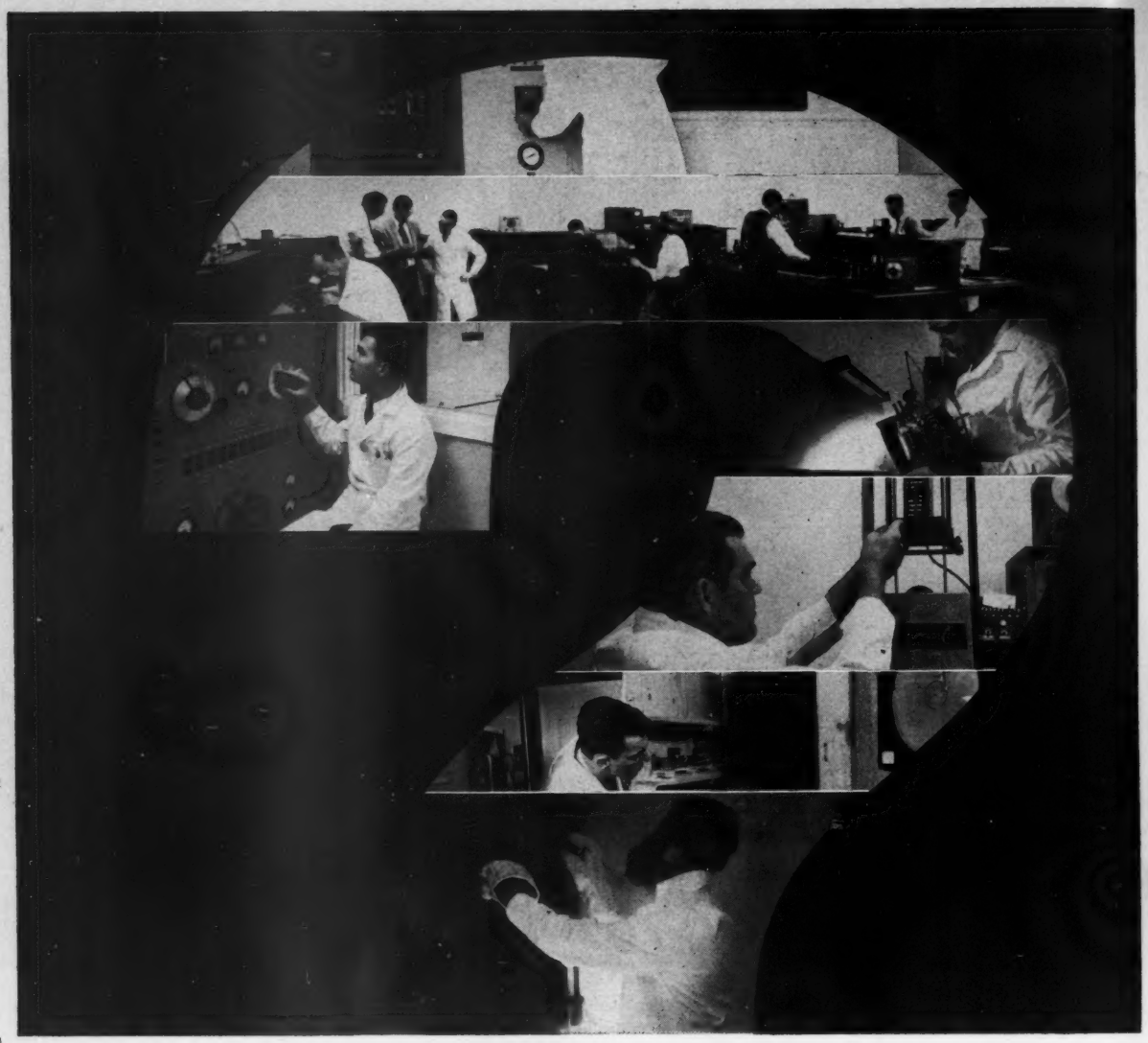

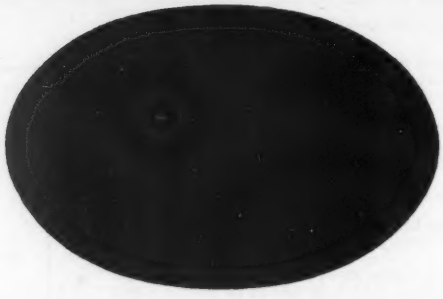

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NEW AC REGULATOR

FAST RESPONSE—LOW DISTORTION

THE FRLD 750

The Only AC REGULATOR with Distortion LESS than 0.35% and Response Time LESS Than 1 cycle — and Regulation Accuracy Held Within ±0.25% for Line and Load Combined!

This *new* type of AC Regulator, the Sorensen FRLD 750, features the ability to reduce line distortion below 0.35%, with *exceptionally* fast response time. Transients caused by line or load changes are suppressed within less than one cycle.

Even when input distortion is above that of normal utility supply, output distortion is reduced by a factor of at least 8:1. The magnitude of transients — line or load — is likewise reduced by the same 8:1 factor.

The new FRLD 750 Regulator provides two output ranges . . . 0-750 and 0-1200 Volt Amps. The instrument weighs only 100 pounds, and dimensions are: 19 x 12¾ x 15⅞ inches.

The cost of this new, high-performing close-regulating Sorensen development is good news too — only $825.

Get the complete story, or a demonstration of its high-level performance, by calling your Sorensen representative. Or wire or write for full technical details.

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These new Raytheon Submin Transistors have one-fourteenth the volume of the JETEC-30 package.

In large quantity production — available from stock

featuring PROVED PERFORMANCE

Over one half million in service

Low leakage current (I_{CO})

High frequency characteristics

COMPUTER TRANSISTORS
Temperature Range −65°C to +85°C

SUBMIN Type	JETEC-30 Electrical Equivalent	V_{CE} max. volts	$f_{\alpha b}$ ave. Mc	H_{FE_1} ave. $I_B = 1$ ma $V_{CE} = -0.25V$	H_{FE_2} ave. $I_B = 10$ ma $V_{CE} = -0.35V$	Rise Time* max. μsec
CK25	2N425	−20	4	30	18	1.0
CK26	2N426	−18	6	40	24	0.55
CK27	2N427	−15	11	55	30	0.44
CK28	2N428	−12	17	80	40	0.33

*I_C — 50 ma; I_{B_1} = 5 ma; R_L = 200 Ω; I_{B_2} = 5 ma; Grounded Emitter Circuit

GENERAL PURPOSE AUDIO TRANSISTORS
Temperature Range −65°C to +85°C

SUBMIN Type	JETEC-30 Electrical Equivalent	V_{CE} max. volts	Beta ave. small signal	Power Gain Class A ave. db	I_{CO} ave. μa	Noise Factor ave. db
CK22	2N422	−20	90	40	6	6 max.
CK64	2N464	−40	22	40	6	12
CK65	2N465	−30	45	42	6	12
CK66	2N466	−20	90	44	6	12
CK67	2N467	−15	180	45	6	12

GENERAL PURPOSE RADIO FREQUENCY TRANSISTORS
Temperature Range −65°C to +85°C

SUBMIN Type	JETEC-30 Electrical Equivalent	V_{CE} max. volts	$f_{\alpha b}$ ave. Mc	Beta ave.	c_{ob} ave. μμf	r_b'' ave. ohms
CK13	2N413	−18	2.5	25	12	70
CK14	2N414	−15	6	40	12	80
CK16	2N416	−12	10	60	12	90
CK17	2N417	−10	20	80	12	100

Dissipation Coefficients for all submin types: in air, 0.75°C/mW; infinite sink, 0.35°C/mW

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ELECTRONICS NEWSLETTER

SUPPLEMENTARY DEFENSE APPROPRIATION to be requested by the Pentagon for the 1959 fiscal year may add up to more than $2 billion. Assistants working on the new request say it may go higher than the $1.3 to $1.7 billion range estimated recently by Secretary McElroy before the Senate preparedness subcommittee. McElroy indicated the total military appropriation would amount to at least $40.9 billion, and possibly to $41.4 billion.

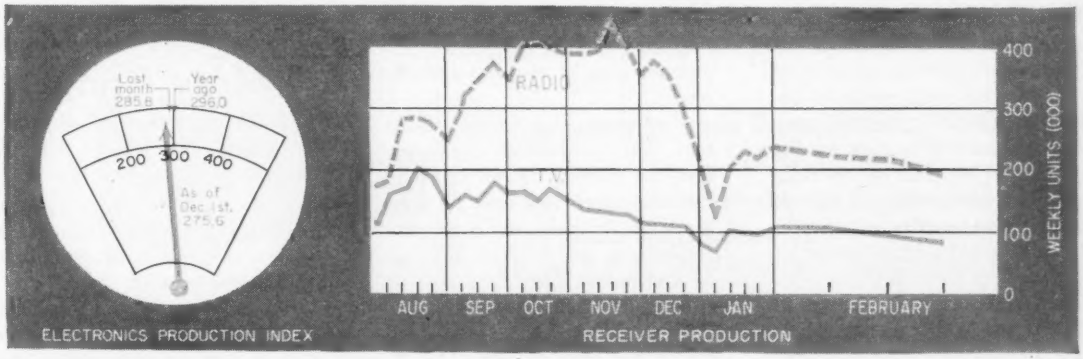
Generally, the additional money will go for ballistic missiles like the Polaris, space projects and continuation of B-52 production into 1960.

ELECTRON BEAM FURNACE for a new melting and metal casting process has been proved on a pilot scale by Stauffer Chemical Co., Mallory-Sharon Metals Corp. and Temescal Metallurgical Corp., the firms that developed it (ELECTRONICS, Jan. 10, p 22). Bombardment by electrons in a high vacuum melts chemically active materials with high melting points. A dozen special metals have already been melted, purified and cast in water-cooled crucibles without contamination.

Economics of electron bombardment melting look favorable at present, says Stauffer, because high voltage d-c electrons are relatively cheap, power efficiencies high. Purification of columbian requires about 3-4 kwh per pound, tantalum about 6-8 kwh per pound. This compares with 500 kwh per pound used in the solid state sintering of tantalum.

ELECTRICIANS' UNION PUSHES ELECTRONICS TRAINING for members. California State Association of Electrical Workers recommends that apprenticeship of an electrician be extended from four to five years to train him in installation of electronic equipment. Union says electronics work has jumped 20 percent in the last three years, and more is expected in both commercial and residential construction. A check of one New York City local reveals that a "preliminary program to get members interested in electronics" has been underway for four months, and that optional evening sessions are so popular the program may be expanded.

NEW USAF SOLID FUEL BALLISTIC MISSILE of 500-5,500 mi range has been approved for development in 4-5 years by Guided Missiles Director Holaday. Missile is part of Minute Man project which envisages underground launching facilities. Improved ICBM nose cone may mean on-target delivery of large warheads will be possible at faster than present planning of 10-15,000 mph.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Feb. 21, '58	Feb. 14, '58	Feb. 22, '57
Television sets, total	86,903	98,841	117,891
Radio sets, total	192,460	211,545	344,507
Auto sets	70,792	68,874	131,108

STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Feb. 26, '58	Feb. 19, '58	Feb. 27, '57
Radio-tv & electronics	45.34	46.49	46.25
Radio broadcasters	55.37	57.40	62.05

FIGURES OF THE YEAR

Totals for year

	1957	1956	Percent Change
Receiving tube sales	456,424,000	464,186,000	− 1.7
Transistor production	28,738,000	12,840,000	+123.8
Cathode-ray tube sales	9,721,008	10,987,021	− 11.5
Television set production	6,399,345	7,387,029	− 13.4
Radio set production	15,427,738	13,981,800	+ 10.3
TV set sales	6,560,220	6,804,756	− 3.6
Radio set sales (excl. auto)	9,721,285	8,332,077	+ 16.7

LATEST MONTHLY FIGURES NEXT PAGE

In New York's Coliseum 20,000 items will be exhibited four days for electronics industry members as . . .

IRE Show Probes Future

More than 50,000 engineers due at New York City convention week from Monday. Three new sessions, industry optimism among highlights

A LOOK INTO THE FUTURE, three new sessions, and electronics industry optimism despite recession talk will be highlights of the 1958 IRE National Convention and Radio Engineering Show starting a week from Monday in New York City.

Among the forward looking sessions will be those on thermonuclear power, electronics in space, automation systems and the impact of electronics on industry.

The world's greatest assembly of technical ideas and products unfolds March 24-27 in the Coliseum. Three sessions will be held for the first time. They will be on radio frequency interference, education, and engineering writing and speech, reflecting recent establishment of IRE groups in these fields.

Overall attendance is expected to be a few thousand over last year's record attendance. Some 850 firms will exhibit 20,000 items worth about $12 million. Exhibitors will represent about 80 percent of the electronics industry's total production capacity.

ELECTRONICS checked and found some exhibitors were running right to the wire on prototype production and testing of new products. Others were awaiting permission to show prestige-building military gear.

From coast to coast electronic engineers and salespeople are now entering two of the year's busiest weeks.

Component, materials, subsystem and production equipment firms are turning out en masse for the show, but there will be fewer big systems shown this year. The emphasis is on products that can be sold in the trade.

Exhibitors report their commercial business has been picking up nicely, the heat generated by the Sputniks has warmed up military business.

The theme of the show—"That New Idea"—is being carried over from last year. The show management feels that it will be more effective as a promotion idea in its second year. New products will be identified by a show sticker and booth staffs will be wearing "New Idea" buttons.

The Radio Engineering Show will again occupy all four floors of the Coliseum: systems on the first floor; components, second and third floors; instruments, third floor; and production gear, fourth.

The technical program, 275 papers in 55 sessions at the Coliseum and Waldorf-Astoria, is the same length as last year. That's just about all that can be squeezed into four days. (See complete program, exhibitor list and booth numbers on p 270).

Presentations were organized by representatives of the IRE's 27 professional groups. Emphasis is still on theory, circuits, systems and parts needed to build markets now developing.

In addition to brisk trading on the floor, manufacturers hope to influence engineers who will make buying decisions back home.

Von Braun Says '5 More Firings'

THE ARMY Ballistic Missile Agency has been given the green light and "financial support for five firings involving satellites or other space projects," says Wernher von Braun, Army's chief of development operations for missiles.

Von Braun would not reveal how much money was approved for the projects, nor would he give a date for the next satellite launching try.

He said the next satellite under

LATEST MONTHLY FIGURES

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Dec. '57	Nov. '57	Dec. '56
Prod. workers, comm. equip.	380,400	398,000	407,800
Av. wkly. earnings, comm.	$78.40	$77.22	$79.15
Av. wkly. earnings, radio	$76.64	$75.08	$75.95
Av. wkly. hours, comm. ..	39.2	39.0	40.8
Av. wkly. hours, radio ...	39.1	38.9	40.4

TRANSISTOR AND TUBE SALES

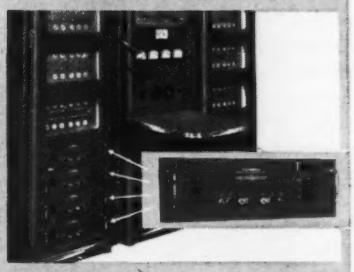
(Source: EIA)	Dec. '57	Nov. '57	Dec. '56
Unit sales	2,773,000	3,578,700	1,608,000
Value	$6,619,000	$6,989,000	$4,691,000
Receiving tubes, units	27,736,000	39,950,000	34,340,000
Receiving tubes, value	$24,881,000	$33,166,000	$29,111,000
Picture tubes, units	644,026	772,801	795,476
Picture tubes, value	$12,971,487	$15,138,438	$13,423,157

Power supply users benefit from outstanding record of field performance

LAMBDA GUARANTEES POWER SUPPLIES FOR FIVE YEARS

DEPENDABILITY IS VITAL

Lambda power supplies are components of IBM's SAGE computer, the world's largest electronic digital computer.



Lambda Com-Pak supplies, with front panel modifications, used by Western Electric to power United States continental air defense system tests.

Standard Lambda power supplies specified by Stromberg-Carlson for multi-million dollar Air Force Digital Computer Intervention and Display System.

Retroactive to all Lambda Power Supplies purchased since 1953

Now Lambda gives you the strongest proof of consistent trouble-free power supply performance ever offered.

The unprecedented five-year guarantee is based on the excellent experience owners of Lambda power supplies have had with their equipment under the most grueling, heavy-duty service.

You are covered not only on new Lambda supplies, but also on all Lambda equipment you have purchased since 1953.

See new Lambda Transistorized Power Supplies at I.R.E. Show

They will be on display in Booths 2436 and 2438. You'll also want a close-up view of Lambda's Com-Pak series, for all needs up to 1.5 amperes. The Com-Pak models are real space savers. They need only 5¼" to 8¾" of front panel height, depending on the model.

Send for latest catalog

Your request, on your company letterhead, brings you complete data on all Lambda power supplies—rack, bench and portable.

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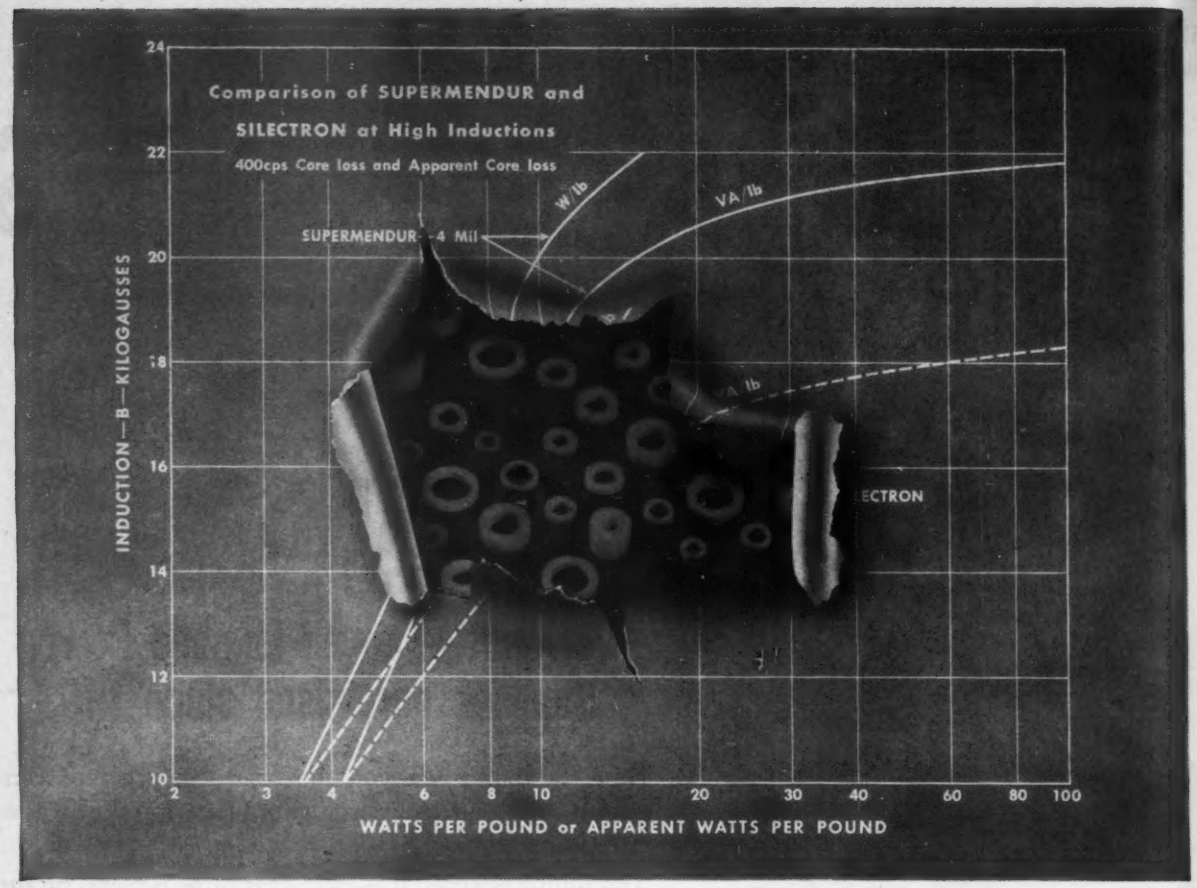

SUPERMENDUR TAPE WOUND CORES
. . . A Real Breakthrough in Miniaturization

The successful development of tape wound cores of Supermendur represents a giant step in the field of circuit miniaturization and simplification. The unique characteristics of this new rectangular-loop core material in the range of induction from 16 to 22 kilogausses permit significant weight and size reduction of toroidal transformers and magnetic amplifiers.

Supermendur, an oriented cobalt-iron-vanadium alloy, combines the high saturation flux density of the cobalt-iron alloys with the desired hysteresis loop rectangularity of the oriented 50% nickel-irons.

Coercive forces substantially lower than those of previously available cobalt-iron alloys are obtained. The lower core losses and excitation properties of Supermendur show a decided improvement in high density characteristics compared with oriented silicon steel, as illustrated by the curves partially shown above. ***Complete curves are available in a new Supermendur Bulletin TC-113, available on request.***

Specific advantages of Supermendur cores in toroidal transformers are: high operating induction, low core loss, low exciting current and high permeability at high induction. In magnetic amplifiers or saturable reactors, they include: rectangular hysteresis loop, high saturation induction and moderate excitation at high induction. Advantages in all uses are: thin tape, small size and low weight.

Supermendur is an ideal material for high temperature core components, because of its high Curie temperature.

● Supermendur is manufactured by Arnold under license arrangement with the Western Electric Company. We'll be glad to send you additional information or furnish you engineering assistance on any of your tape core applications if you'll just drop us a line.

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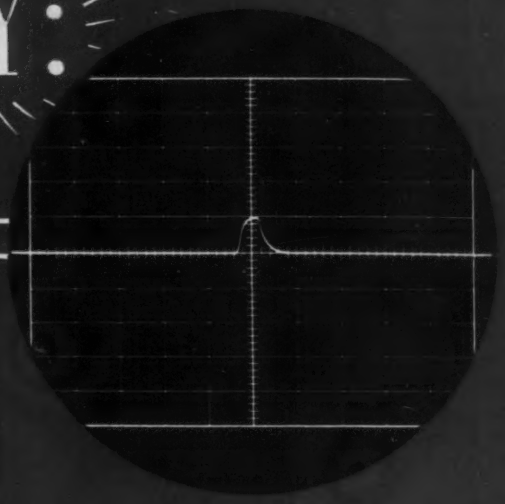
SENSITIVITY:

100 μVOLTS

PER SCALE DIVISION

(without pre-amplification)



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DU MONT 403

The Du Mont 403 is the most sensitive oscilloscope commercially available. This outstanding sensitivity permits direct measurements from low output transducers such as strain gages, pressure pickups, accelerometers, heart monitoring equipment, and others that normally require pre-amplification.

The 403, when used as a direct-reading voltmeter, offers full scale amplitude measurements from 1 millivolt to 500 volts, continuously variable in 17 steps. At maximum sensitivity, the 403 allows resolution of signals in the region of 20 microvolts.

Stability, commensurate with this outstanding sensitivity, is another feature of the 403.

The 403 is another in the Du Mont 400 Series Instruments. It is designed for fast, easy, and accurate measurements, along with complete accessibility and reliability.

One of the 400 Series

FEATURING

AMPLIFIERS: Direct coupled amplifiers. Single-ended or balanced Y-input.
EXTREME SENSITIVITY: 1 millivolt to 500 volts full scale, continuously variable.
FREQUENCY RANGE: DC to 300 KC.
Y AMPLIFIER CALIBRATION: 5%.
SWEEPS: 19 calibrated linear sweeps, 0.5 sec/cm to 0.5 μsec/cm. Calibrating accuracy, 5%.
EXPANDED SWEEP: Any 10 cm portion of 50 cm sweep may be expanded 4 times and positioned on screen.

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his control will be in the same bullet shape as Explorer I.

Von Braun said the program "does not imply we'll hit the moon."

The next satellite, he said, will utilize a built-in miniaturized tape recorder and receiver with a "little electro-motor to wind up the spring for the tape.

"A signal from the ground will trigger the recorder when it is passing over our western hemisphere, and give us the recorded data gathered by instruments on the other side of the world," Von Braun said.

Space Age Needs Manned Aircraft

WASHINGTON—Producers of electronic equipment for manned aircraft will share, along with makers of missiles, in the stepped up U. S. spending for military hardware.

This was the belief of those attending the recent Air Force Association's Jet Age Conference here.

By far the most predominant single issue brought out was the continuing need for manned bombers, regardless of progress in ballistic missiles.

This recurring theme was stressed by all Air Force speakers. Lt. Gen. Francis H. Griswold, Vice Commander-in-Chief, Strategic Air Command: "For the foreseeable future, missiles will supplement and complement rather than replace the manned bomber."

Maj. Gen. James Ferguson, Director of Requirements, Deputy Chief of Staff, USAF said: "Since there are signs that significant elements in the country would stampede us into outer space, leaving little else behind, I am happy to help put into proper perspective the continuing operational need for manned aircraft."

Ferguson added: "The attribute of wide discretion is one we cannot build into a machine. It becomes apparent, then, that we must preserve and refine our manned systems, if for no other reason, for this discretionary capability alone. With all their capability the destructive power of the missile is not equal to that of the manned bomber."

WASHINGTON OUTLOOK

NAVY's super secret project ASROC, antisubmarine rocket, reportedly is a large-scale version of its recently announced antisubmarine weapon RAT, a rocket-thrown weapons system. Minneapolis-Honeywell is the prime contractor, with Librascope handling the electronics end of the project.

Basically, the system searches out submarines, then launches rockets for undersea kills. It is said to use electronic digital fire-control computers for the first time on surface ships.

Navy has touted its RAT project as the hottest thing yet in antisubmarine warfare. Presumably this is a small scale test of the coming ASROC project. Minneapolis-Honeywell doesn't admit the project exists, but it is known that the project is being handled from a West Coast plant. Librascope's subcontract amounts to $17-million.

- A new entry in the sweepstakes to develop new missiles is the Air Force's Minute Man, a solid propellant ICBM. The Pentagon has authorized the Air Force to push ahead on research and development. None of the project contractors has been officially revealed. But it's believed that Aerojet-General, Thoikol, Phillips Petroleum and Grand Central Rocket are competing for a production contract on the missile's engine.

  Presumably, the propulsion subsystem is being pushed the most right now, with the belief that advanced models of the GE-Burroughs guidance system for the liquid-propellant Atlas ICBM or the Arma-Bell Lbs system for the liquid-propellant Titan ICBM could be incorporated at a later date in Minute Man.

- The trend toward stronger military unification—and more centralized Pentagon control over weapon development and production—could be sidetracked by a bill introduced by Rep. Carl Vinson (D., Ga.), the powerful chairman of the House Armed Services Committee and Rep. Leslie C. Arends (R., Ill.), the committee's ranking Republican and House whip for his party.

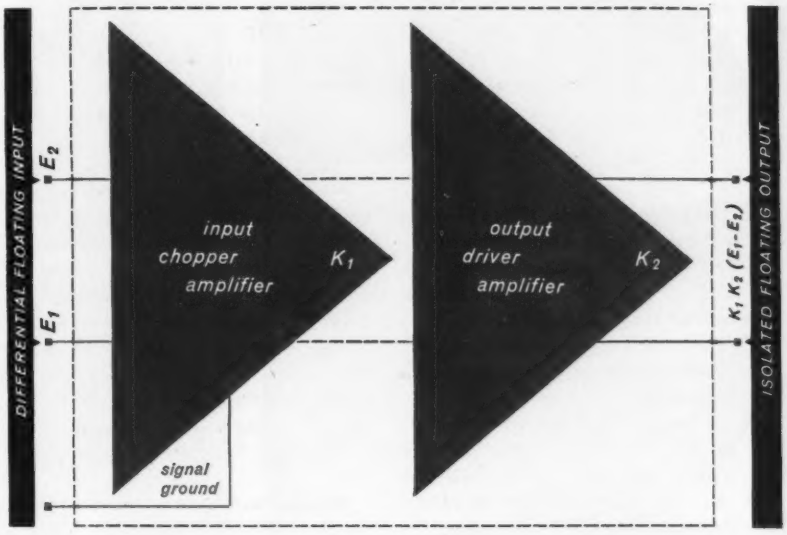
  The bill would cut the Secy. of Defense's office from 2,400 persons to 600, eliminate 14 of the Pentagon's roster of 29 under secretaries and assistant secretaries, substantially restrict the authority of the Defense Comptroller and elevate the civilian secretaries to membership in the National Security Council.

  In effect, the bill seriously reduces the Defense Secy.'s central powers, creates greater authority for the individual services. This is in direct conflict with the proposals, now being considered by the administration, to reorganize the Defense Dept. with stress on unifying military organization and policy.

  Some Pentagon sources consider the Vinson-Arends bill an effort to temper the Administration reorganization plans now being worked up for Congressional consideration. Both Vinson and Arends are conservatives on the organization issue, strongly oppose the creation of a single chief of staff, greater authorities for Defense Secy., and all other trends toward greater unification.

- Government officials say reliability of electronic parts in rockets and missiles has reached the stage where the prime missile makers themselves—Convair for one—are pumping as much as 75 percent of their development funds into searching for better electronic materials and components.

New! KIN TEL's true differential DC amplifier...

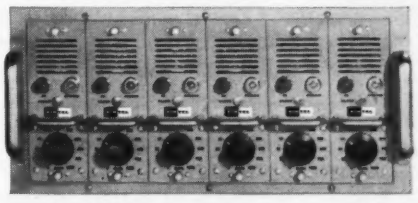


completely isolates input from output!

AMPLIFY MICROVOLT-LEVEL DATA SIGNALS New transistorized differential DC amplifiers provide extremely high common-mode rejection, very low drift, high output capability, and excellent stability and linearity... all unaffected by load or gain changes. Ideal for thermocouple amplification, they eliminate ground loop problems; allow the use of a common transducer power supply; permit longer cable runs; drive grounded, ungrounded or balanced loads, and can be used inverting or non-inverting. The 114A is the *perfect instrumentation amplifier.*

BRIEF SPECIFICATIONS – 114A DIFFERENTIAL DC AMPLIFIER

- 120 db common-mode rejection from DC to 60 cps.
- Gain of 10 to 1000 in 5 steps, continuous variation between steps.
- Gain accuracy 1.0% DC 10 cps, 3% to 30 cps, 3 db down at 120 cps.
- DC gain stability and linearity 0.1%.
- <5 μv noise; <5 μv drift at gain of 100 or above.
- Maximum output capability 10V at 10 MA.
- 100 K ohm input, <1 ohm output Z (min. load res. 20 ohms, max. load cap. 1.0 μf).



Six KIN TEL amplifiers in compact 19" rack mountable module.

STANDARD WIDEBAND DC AMPLIFIERS can be used single-ended or for floating input applications. An operational version permits the user to employ his own feedback networks to limit bandwidth, generate transfer functions, obtain specific gains and perform integrations. Specifications for the 111 series, Wideband DC Amplifiers include: <2 μv drift; <5 μv noise. ±35 V, ±40 MA output. 100 K ohm input, 1 ohm output Z; 1.0 μf allowable output cable capacity. 0 to 1000 gain in ten steps, with continuous 1 to 2 times variation of each step. Gain accuracy (freq. response) ±1.0% DC to 2 KC, <3 db down at 40 KC.

ALL KIN TEL DC AMPLIFIERS feature integral power supplies, convenient plug-in mounting and KIN TEL's proven chopper feedback amplifier circuitry for unsurpassed stability, accuracy and reliability. They have accumulated over 500 years of operating time, and in one installation alone have logged over a million hours of trouble-free operation. Records like this are the result of stringent quality controls, thorough testing and calibration, and years of experience in the design and manufacture of thousands of chopper stabilized DC amplifiers.

FOR GREATER ACCURACY, SIMPLICITY, RELIABILITY, and the elimination of carrier system balance problems, replace complex carrier systems with a KIN TEL packaged "plug-in" DC instrumentation system — complete from input transducer to output device.

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and probably more than we envision now, man will fly the equipment. Man's judgment and skills will always be needed to achieve the greatest effectiveness."

George E. Valley, Jr., USAF's Chief Scientist: "Missiles are indeed new weapons, but they are additions to our armament; their properties are complementary to those of the manned aircraft."

Gen. C. S. Irvine, Deputy Chief of Staff, Materiel: "Missiles and manned aircraft are getting more alike as to design. But missiles are going through a trial period. When judgment is required and when the reliability is assured, then man will be put into missiles."

Previously, ELECTRONICS (Feb. 7, p 13) quoted Major Alexander de Seversky's statement before the Senate Preparedness Subcommittee: "For any predictable time, the hypersonic, manned vehicle will be the decisive weapon in any future war. In general, robots are too logical. Their reaction is predictable; they are easier to intercept."

Tv Multiplex Shows Progress

PRESENT STATUS of development in a tv multiplex system was recently demonstrated in Newark, N. J., to leaders in government and industry. Originally announced last fall (ELECTRONICS, Oct. 10, '57), system which then was in drawing-board stage has since developed into the form of experimental hardware.

Developers of the Bi-Tran system assert that more refinement is necessary before it can be offered to the industry as a commercial possibility.

One problem is to get perfect phase cancellation between the two video signals. At present there is interlineation and video crosstalk in both channel A and B reproduction.

In addition to possibility of using B channel for subscription tv, promoters also envision uses of existing networks and stations for hitchhike by military, educational, medical, civil defense and other emergency services.

MILITARY ELECTRONICS

• **Projects USAF** and/or the Department of Defense are studying include: sending a 3,000-lb reconnaissance satellite into orbit via an ICBM Atlas; accelerating R&D work on ICBM Titan; developing a solid-fueled ICBM not as "awkward" as liquid-fueled Atlas and Titan; extending production of the B-52; and reexamining Army's IRBM Jupiter in comparison with USAF's Thor.

• **Airborne Bendix-Decca pictorial navigation** equipment for helicopters is being evaluated in the New York area by the Airways Modernization Board. Objective: to what extent will a hyperbolic system expedite helicopter operations in a high-density terminal area?

Four organizations are associated in the program: Pacific div. of Bendix will furnish, install and maintain the equipment; Bell Helicopter will modify a helicopter, installing advanced types of instrumentation developed by Bell and Bendix; New York Airways will fly the units; and Airborne Instruments Labs will provide engineering aid to AMB during the program, and will measure the technical performance of the system.

• **Airways Modernization Board** has awarded a $4,272,484 contract to General Precision Labs for design, development and fabrication of enroute portion of AMB experimental semiautomatic traffic control data processing system for civil and military air traffic control.

The AMB also started negotiations with GPL for the development of the high-density terminal portion of the automatic data processing and display element.

• **Combination data processing** and closed circuit tv to be used for testing Navy's IRBM Polaris was developed by Siegler's Hallamore Electronics div. under a $1-million R&D contract with the Naval Ornnance Test Station, Pasadena. The system's data reduction equipment contains electronic devices for calibrating all equipment prior to testing or firing the missile.

• **Range and accuracy of infrared** homing missiles will be increased due to the development of a hyperpure monocrystalline silicon disk lens with a 4-in. plus diameter, according to developer Friedrich Schwarz, U. S. Semiconductor Products, Inc., located in Phoenix, Ariz.

Schwarz declares that the new lens makes it possible to detect and home in on an enemy missile from 1,000 mi.

New Weapon

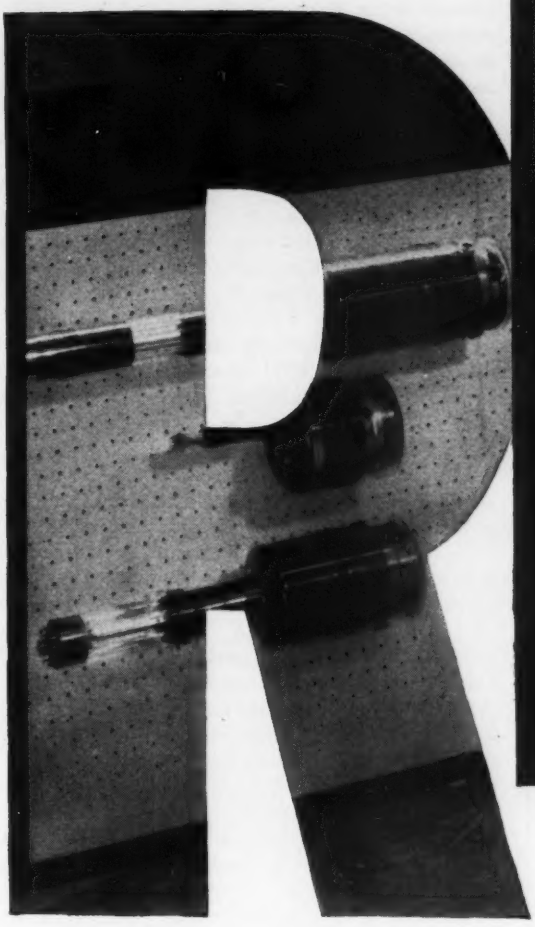
MB-1 Genie, air-to-air rocket, is shown in front of its launcher, the McDonnell F-101B Voodoo. Hughes' electronic fire control system locates target and fires armament. Genie, built by Douglas, is part of CONAD's arsenal

Space Challenge To Electronics

CHICAGO—THE PROBLEM of "instrument display and controls in a space ship offers considerable challenges to the present state of the electronic art," says Brig. Gen. Don Flickinger, director of Human Factors and surgeon at the Baltimore Headquarters of the U. S. Air Research and Development Command.

The pilot and medical scientist told ELECTRONICS that "in the next four to five years I can see the possibility of putting in space a man who is contributing something to the instrumentation system, and

booths 2801-05



I.R.E. show

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For a period of years these Hughes cathode-ray tubes have been in commercial and military operation and have established an outstanding record of reliability. See these tubes actually perform in typical applications at the I.R.E. show in New York. Or, for further technical data write: Hughes Products, Electron Tubes, International Airport Station, Los Angeles 45, California.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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recovering him after a five day period."

Gen. Flickinger added: "Extremely small energy requirements will carry out necessary communication functions between the space man and the ground staff. We do not have a space communication system now, but we do have components of a system we know will work in a vacuum chamber."

The Air Force scientist said some electrochemical techniques of dealing with gases and rearranging them for the space man's safety at relatively small watt cost and energy "show promise."

"In the next couple of years we can come up with an electrochemical process to extend the time base from five days to probably five weeks or two months.

"We are doing this now with special battery powered units operating at about ¾ of a kilowatt. It provides power for 24 hours. The total unit for one man oxygen day weighs 75 lbs."

The X-15 airplane will be tried out in 1959, he said. "Certain instruments in the vehicle will have to be displayed in a manner so a man can quickly make a decision and instigate action on this judgment."

Selling Seats By Wire Line

Braniff airline hostess queries equipment about seat availability on her flights by using key-set machine

RECENTLY, Braniff International Airways unveiled its new electronic reservation system in Dallas, Texas.

The equipment, constructed by Teleregister, uses teleprinter equipment. Teleprinters feed reservation requests and seat information directly into the electronic equipment. Space can be sold or canceled in a few seconds.

With the new equipment, reservation clerks in remote cities can now query a central electronically controlled inventory of seats in a distant city directly by teleprinter. Agents in 140 branch offices of the airways are connected into the reservation system by 18,000 miles of land line.

FINANCIAL ROUNDUP

• **Consolidated Electrodynamics,** Pasadena, Calif., and **Cenco Instruments** of Chicago give up on plans to merge the two firms. The proposed merger reportedly bogged down because of difficulties of merging people of the two organizations. Employment contracts of key Cenco personnel did not conform with CEC policies.

• **Sylvania Electric** offers two long term debenture issues totaling $40 million. The double issue comprises $20 million of senior debentures due in 1980 and $20 million of convertible subordinated debentures due in 1983. Receipts from the senior issue are being used to pay off three year bank loans due in 1960. Convertible receipts are going for additional working capital required for expanded operations and new defense projects. Paine, Webber, Jackson & Curtis and Halsey Stuart & Co. head the underwriting group.

• **Barry Controls,** Watertown, Mass., purchases physical assets and products of **Vlier Engineering** of Los Angeles. Payment was in cash and five year notes, but amount was not disclosed. Vlier will operate as a Barry subsidiary. It makes tooling accessories for dies, jigs and fixtures used in the metal working industry. Barry's principal business is the design and manufacture of mounting systems and components to protect electronic and other equipment from shock and vibration. Acquisition gives parent company additional diversification outside the military field.

• **Digitronics Corp.,** Albertson, Long Island, N. Y., plans to issue 140,000 shares of class B capital stock at $1.50 per share. Proceeds are to be used for corporate purposes. Cortland Investing Corp. of N.Y.C. will underwrite the issue.

• **Ling Electronics** of Los Angeles and **Ling Industries** of Dallas, Texas, consummate merger plans as stockholders approve proposal. Ling Electronics, the surviving corporation, will maintain executive offices in Dallas. Principal product of Ling Electronics is vibration testing equipment used in the missile and jet-aircraft industry.

• **Marchant Calculators,** Oakland, Calif., reduces quarterly common divident to 15 cents per share. It had previously paid 32½ cents. Step was to conserve cash needed for corporate purposes and for move into new building.

• **Sanders Associates,** Nashua, N. H., pays semiannual dividend of 4 cents per share on common today. It had paid quarterly dividends of 2 cents per share.

• **General Precision Equipment** declares a dividend of 60 cents on common shares payable tomorrow. Regular quarterly dividends, payable at the same time, were also declared on $4.75 cumulative preferred stock, the $1.60 convertible preference stock and the $3 cumulative convertible preference stock.

F-M Triplecasts Seen Profitable

REPORTS of recent success in broadcasting three programs simultaneously are gaining the attention of f-m broadcasters and receiver manufacturers alike.

Trial triple broadcasts are being made by WGHF (f-m), Brookfield, Conn. with FCC approval. Programming consists of stereo-

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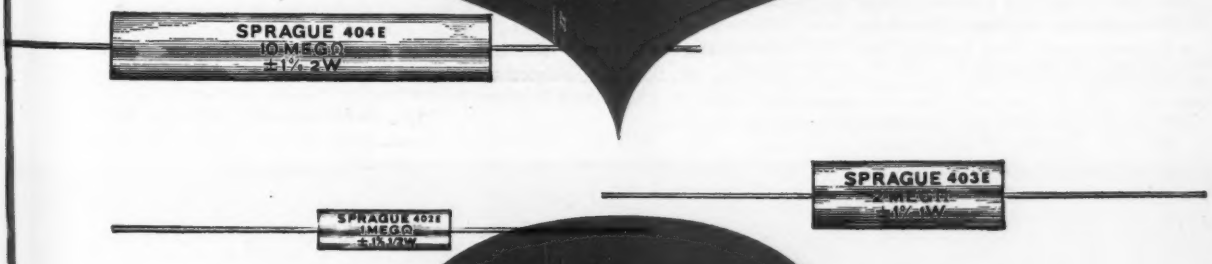

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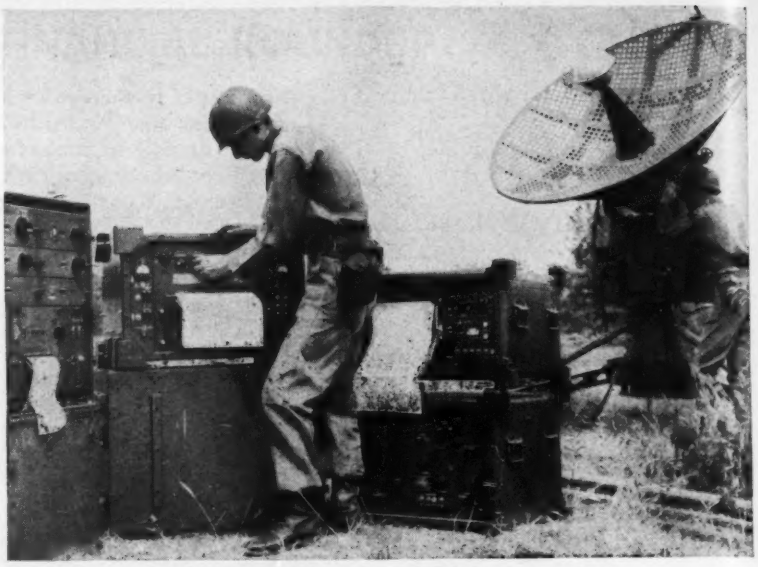
phonic hi-fi music and commercial background services.

Financial prospects for this type of operation look good according to WGHF's owner, A. J. Detzer. He says hi-fi stereo music will have considerable appeal in his Westchester and Fairfield County areas, while commercial background servicing will find ready customers.

If FCC approves, the station plans to have f-m stereocasts on regular schedule as soon as adapters for home receivers become generally available.

Several manufacturers are reportedly interested in this new potential market. Prices for the multiplex adapters are expected to run somewhat under $100.

Broadcasts are made by using the main channel and one subchannel for hi-fi stereocasts, and the other channel for background service. Reports say no interference problems arise from this multiplexing.



Meteorology Computers

Computer packaged in battlefield console automatically issues high-altitude weather reports. An antenna tracks the balloon, other basic information is radioed from instruments on the balloon. System, developed by Army Signal Engineering Laboratories, provides vital pressure, humidity, temperature and wind readings

MEETINGS AHEAD

Mar. 17-21: 1958 Nuclear Congress, Engineers Joint Council, AICE and Atomfair, Atomic Industrial Forum, International Amphitheatre, Chicago.

Mar. 18-19: Conf. on Extremely High Temperatures, Air Force Cambridge Research Center, New England Mutual Hall, Boston, Mass.

Mar. 24-27: IRE National Convention, All Prof. Groups, Waldorf-Astoria Hotel and N. Y. Coliseum, N. Y. C.

Mar. 31-Apr. 2: Instruments & Regulators Conf., PGAC, ASME, AICHE, ISA, Univ. of Delaware, Newark, Del.

Mar. 31-Apr. 2: Southwest District Meeting of AIEE, Mayo Hotel, Tulsa, Oklahoma.

Apr. 2-4: Conf. on Automatic Optimization, PGAC, ASME, AICHE, ISA, Univ. of Delaware, Newark, Del.

Apr. 8-10: Sixth National Conf. on Electromagnetic Relays, Oklahoma State Univ., Stillwater, Okla.

Apr. 8-10: Symposium on Electronic Waveguides, Microwave Research Institute of Brooklyn Polytechnic Inst., head at Engineering Societies Bldg., N. Y. C.

Apr. 10-12: Tenth Southwestern IRE Conference and Electronics Show, St. Anthony Hotel and Municipal Auditorium, San Antonio, Texas.

Apr. 14-16: Conf. on Automatic Techniques, IRE, ASME, Statler Hotel, Detroit, Mich.

Apr. 15: Closing date for registration, Intensive course in Automatic Control scheduled for June 16-25 at Univ. of Mich., Coll. of Engineering.

Apr. 17-18: Second Annual Tech. Meeting, Institute of Environmental Engineers, Hotel New Yorker, N. Y. C.

Apr. 18-19: Twelfth Annual Spring Tech. Conf. on Television and Transistors, Engineering Society of Cincinnati Bldg., Cincinnati.

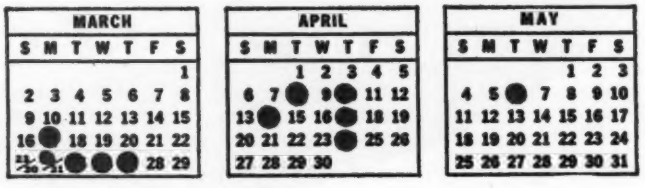
Apr. 20-24: Scientific Apparatus Makers, 40th Annual Meeting, El Mirador Hotel, Palm Springs, California.

Apr. 21-25: Society of Motion Picture and Television Engineers, 83rd Convention, Ambassador Hotel, Los Angeles.

Apr. 22-24: 1958 Electronic Components Conf., IRE, AIEE, Theme: "Reliable Application of Component Parts," Ambassador Hotel, Los Angeles.

May 6: Western Joint Computer Conf., First National Symposium on Modern Computer Design, Ambassador Hotel, Los Angeles.

May 19-21: Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.



DATA SHEET

PHILLIPS

REMOVE AND FILE FOR REFERENCE

SERIES 34 & 36 SUB-MINIATURE RELAYS

UNIQUE NON-RESONANT ARMATURE RETURN SPRING

In Series 34 and 36 sub-miniatures, the armature return spring is enclosed within the pole piece and is adjusted to extremely close limits. Because of its novel design, it is effectively dampened to prevent natural resonance. The movable springs are of a "safety pin" type. While providing adequate current capacity to carry the military requirement of four times rated load for overload test, they have very small mass and a high natural resonant frequency.

DC-34 & DC-36 ASSEMBLY FEATURES

The entire structure of these sub-miniatures is designed to provide long life with a high degree of reliability.

All units are hermetically-sealed. Materials used in their construction are of high temperature types. All insulation materials are inorganic, assuring non-gassing to minimum temperatures of 400° F.

These relays will not malfunction under extremes of vibration and shock, meeting military environmental requirements. Further, they conform exactly to military standards for dimensions and mountings, thus insuring interchangeability with contemporary types.

Standard coil and contact rating, listed on the reverse side, are conservative. Additional ratings are available for special requirements.

Adequate insulation is provided to insure an insulation resistance of 1000 megohms minimum when measured at 500 volts DC and a dielectric breakdown of 1000 volts rms between all terminals and case and between adjacent contact sections.

Special contact materials are available for switching in the low level or "dry circuit" range. Excellent reliability can be obtained in this application.

DC-34 & DC-36 DESIGN FEATURES

The motor assembly features a very tightly closed magnetic circuit, which results in low magnetic leakage and high magnetic efficiency since the entire field is concentrated in the useful area. Properly annealed armco is used to provide high permeability and freedom from residual magnetism.

A special coil design, with minimum amount of inorganic insulating material and no impregnating varnish, permits an unusually high number of ampere turns in the magnetic field.

A special modified solenoid type armature is extremely lightweight — the entire armature and actuator assembly weighs only 2.2 grams. This armature is capable of operating the heavy spring load and furnishes a favorable weight to spring ratio for better resistance to external forces.

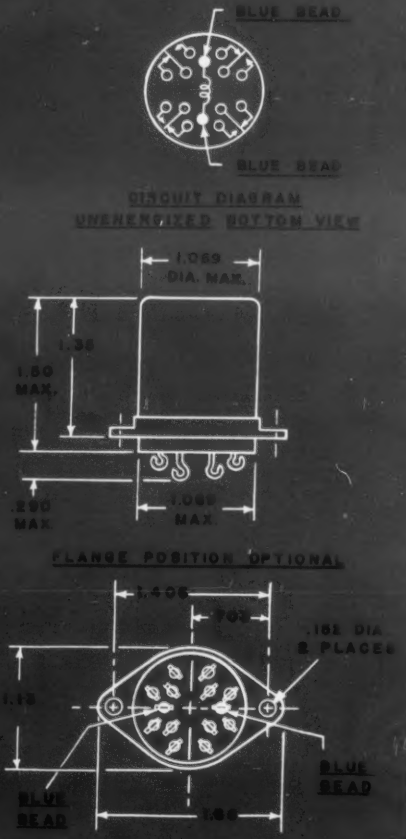
Movable contact is a spherical bead permanently coined on the contact spring. Stationary contacts are fabricated from beryllium copper overlaid with silver. All contact assemblies are heavily gold-plated to prevent oxidation prior to hermetic sealing.

In adjustment of the contact groups, adequate pretravel and over-travel are provided to compensate for wear and erosion of contact surfaces, assuring high contact pressure throughout a long and useful life.

Remove and file for reference.

Perforated for easy tear-out.

SERIES 34 & 36 SUB-MINIATURE RELAY AND SUB-ASSEMBLIES



DC-34	CHARACTERISTICS	DC-36
4PDT-(4 Form C)	Contact Form	6PDT-(6 Form C)
up to 300v. D.C.	Coil Voltage	up to 300v. D.C.
up to 22,500 ohms.	Coil Resistance	up to 27,500 ohms.
50G, 11ms.	Shock (operating)	50G, 11ms.
30G to 500c.p.s. 20G to 2,000c.p.s.	Vibration (operating)	30G to 500c.p.s. 20G to 2,000c.p.s.
–65°C to 125°C	Temperature Range	–65°C to 125°C
3.25 oz.	Weight	4 oz.
MIL-R-25018	Specifications	MIL-R-25018
Solder or Plug-in	Terminals	Solder or Plug-in
	DETAIL SPECIFICATIONS	
32	Max. Operating Voltage	32
26.5	Nominal Coil Voltage	26.5
18v. Max.	Pick-up Voltage @125°C	18v .Max.
13v. Max.	Drop-out Voltage @125°C	13v. Max.
240 ohms. Min.	Coil Resistance @25°C	200 ohms. Min.
Silver	Contact Material	Silver
2 amps.	Contact Rating, Resistive	2 amps.
100,000	Minimum Operating Life	100,000
Continuous	Rated Duty	Continuous
9ms.	Operate Time	9ms.
3ms.	Release Time	3ms.
.05 ohms Max.	Contact Resistance	.05 ohms Max.
1,000 Meg. Min.	Insulation Resistance	1,000 Meg. Min.
1,000 RMS	Voltage Insulation	1,000 RMS

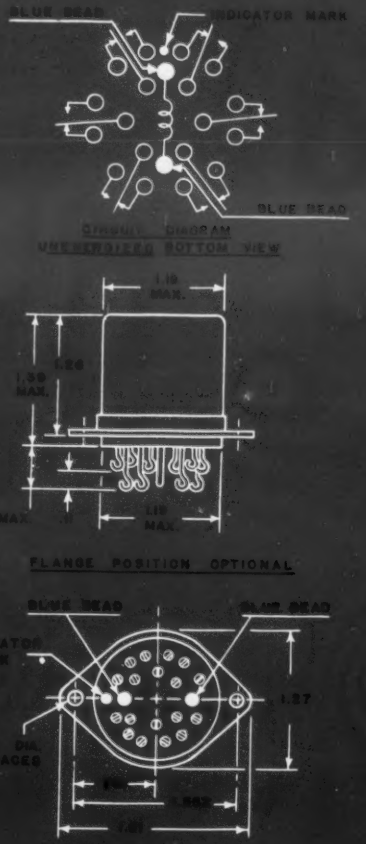


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FIG. 1—
board w
ELECTR

electronics
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MARCH 14, 1958

Etched I-F Amplifier Pares Color Tv Cost

Vane-tuned inductances and rejection traps, etched on the same board as the wiring of a 41-mc i-f strip for color tv, provide neat and economical design technique. Design requirements and performance data are covered completely for a typical i-f strip and construction details given

By **LINUS RUTH*** Laboratories RCA Ltd. Zurich, Switzerland

ETCHING INDUCTANCE COILS and traps on the same board as the wiring can save considerable material and labor costs. This is especially true in a 41-mc i-f strip for color tv to be described where the number and complexity of inductances make is possible to fully realize the economies of printed circuitry. The bill of material saving alone compared to conventional three tube color i-f strips is approximately 25 percent.

Requirements

In a wide-band color i-f amplifier there must be sufficient bandwidth at the chrominance detector to handle the 42.17-mc color subcarrier and both sidebands up to 500 kc from the color subcarrier (B-Y, R-Y demodulation).

The bandwidth at the luminance detector should produce resolution in line with good monochrome practice. There should be 26 to 30 db sound attenuation at the sound detector for proper intercarrier operation; approximately 50 db minimum adjacent picture attenuation; approximately 50 db minimum adjacent sound attenuation with no phase degradation in the vicinity of the picture carrier, and approximately 50 db minimum sound attenuation at the luminance detector for elimination of 920-kc sound-color beats. Also, the picture carrier at the chrominance detector should be of greater amplitude than the chroma subcarrier to prevent luminance modulation of the chroma subcarrier.

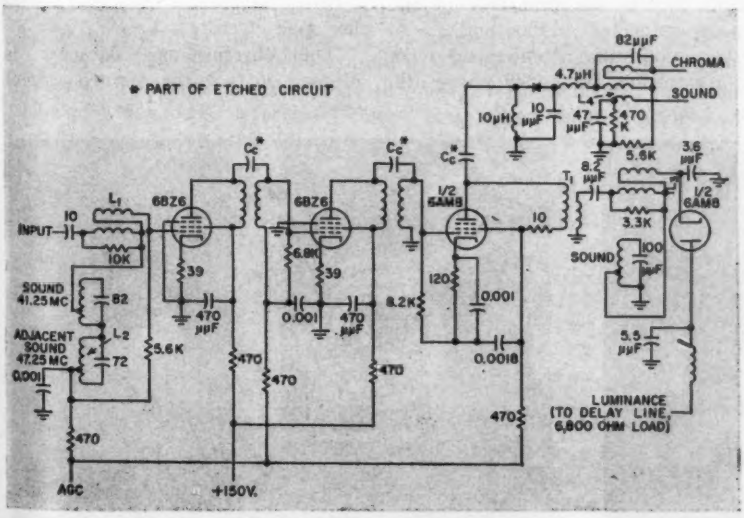
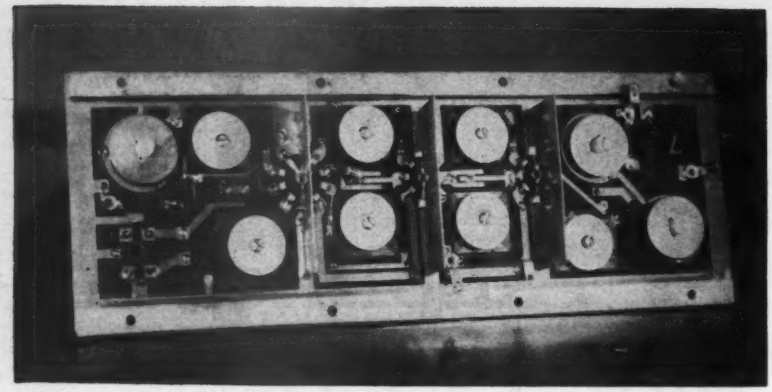


FIG. 1—Schematic diagram of the 41-mc I-f amplifier. Traps are printed on the same board with the wiring and other coils and are vane tuned

Design

The mixer to first grid is overcoupled with low side capacitance

*Formerly associated with Standard Coil Products, Los Angeles, Calif.



Photograph of i-f amplifier showing layout and spacing arrangement between the coils in the center of the strip. This arrangement greatly reduced d-c leakage

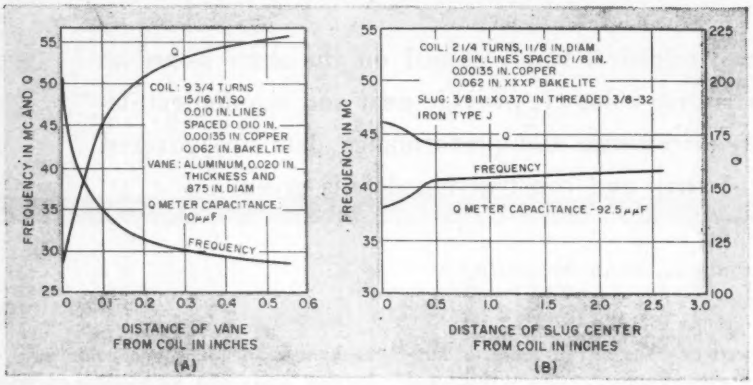


Fig. 2—Frequency and Q plotted against distance from the coil using aluminum vanes on steel screw (A) and powdered iron slug tuning (B)

coupling and two bifilar T traps; one sound and one adjacent sound. See Fig. 1. The next two stages are grid loaded and overcoupled, chosen in preference to a staggered pair because it was felt that the problem of holding the coupling would be alleviated with coils on the same board and provide additional stage gain.

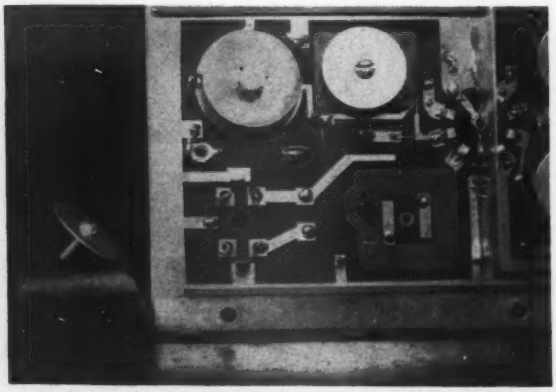
Attenuation of the two bifilar T traps in the grid of the first i-f is adjusted by a tap on the adjacent sound trap L_2 and the balancing resistor across the first half of the cross connected bifilar coil L_1 to give maximum attenuation with minimum low frequency phase disturbance. The sound trap tap is adjusted to give 28 db sound attenuation at the sound and chroma detector. With this adjustment, attenuation of adjacent sound varies from a minimum of 50 db to a maximum of over 70 db with a ± 5 percent variation of the resistor. The sound trap only varies from a minimum of 25 db to a maximum of 30 db.

One of the problems with printed bifilar coils used in a stagger-tuned circuit is that d-c leakage develops between the plate coil and the grid coil. The B + potential is usually 130-150 v and agc potential is -3.0 v or so, at relatively high impedance. The seriousness of this leakage is greatly reduced by the relatively small area and increased spacing of the coupling capacitor between the coils in the center of the strip.

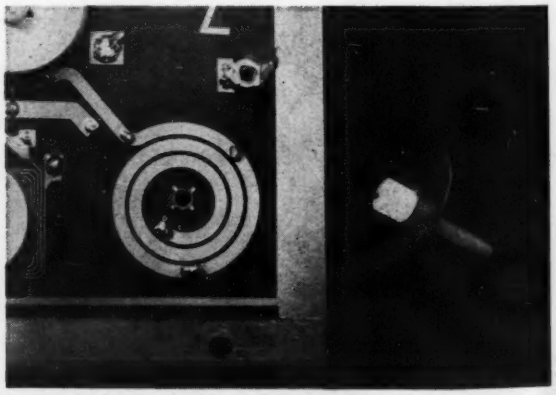
There are three bifilar coils on the strip, used in conjunction with the bifilar traps. Coil L_1, in the grid of the first i-f shown in Fig. 1 and L_3 in the detector circuit have no d-c potential between coils. The d-c potential across T_1 could be avoided by returning the grounded end of the secondary to B+ with a 0.001-μf bypass to ground at that point.

Detectors are overcoupled with a bifilar T sound trap in the luminance detector. A 6,800-ohm delay line is used for the luminance detector load and negative mutual peaking is used in the video amplifier grid circuit.

The chrominance detector is aligned so that the picture carrier



Closeup of i-f amplifier shows the aluminum vanes, mounted on steel screws, used for tuning the coils



View of the bifilar trap with vane removed shows nylon-screw mounting hole. Screw and vane are at right

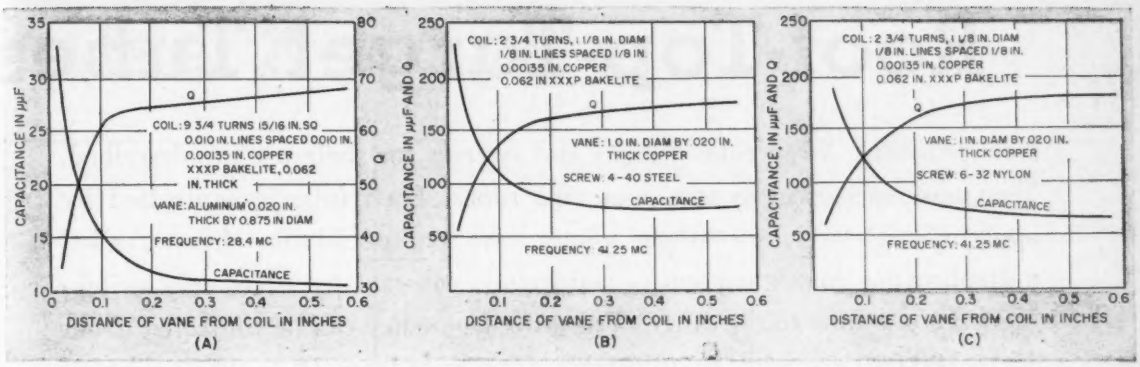
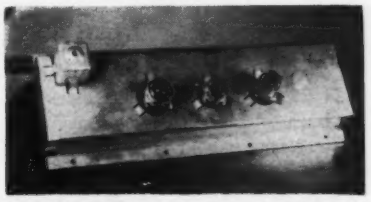


FIG. 3—Capacitance and Q plotted against vane distance from trap coil using aluminum vane (A), copper vane mounted on steel screw (B) and copper vane mounted on a nylon screw (C)



The i-f strip with the top shield removed (left). Shielding for the sound trap in the luminance detector circuit is taken care of by a small copper strip enclosing the trap on sides not adjacent to ground

is several db above the chroma subcarrier.

Coils are vane-tuned with aluminum vanes on steel screws. This tuning method is inexpensive and gives greater tuning range than slug tuning. However, when the vane gets close to the coil, the coil Q deteriorates seriously, as shown in Fig. 2A. Coil inductance is adjusted so that the vane never comes closer than 0.125 in. and the Q variation is kept within ± 10 percent of the nominal value.

Figure 3A shows that a total variation in circuit capacitance of 3.5 $\mu\mu$f may be satisfactorily compensated. Since this is several times the expected capacitance variation, it is safe to exclude from the operating range the 0.125 in. closest to the board.

The traps are also printed on the same board with the wiring and other coils. The original tuning method used with the traps was a powdered iron disk. However, this method resulted in low Q and a restricted tuning range. Later a large threaded slug was used in conjunction with a threaded nylon tube to allow the slug to be withdrawn from the field of the coil. The Q is satisfactory but the tuning range is still restricted, as shown in Fig. 2B.

Trap inductance was increased by extending the winding into the space formerly occupied by the slug, maintaining the same outside diameter and vane tuning with a copper vane mounted on a steel screw was tried. If the Q is maintained above 150, the vane must be kept 0.15 inch from the board and a capacitance variation of ± 10 percent of 83.5 $\mu\mu$f may be compensated, as shown in Fig. 3B.

With the same configuration and a nylon screw mount, the Q may be maintained above 160 for the same capacitance variation, as in Fig. 3C.

Shielding

Small shields installed across each tube extending to the edge of the strip provide decreased impedance in the ground paths and shield adjacent stages. Further shielding is provided by bottom and top covers. The grounding strip that extends up from the tube socket to ground the tube shield is not of sufficiently low impedance, therefore each tube shield is grounded to the top cover by three springs.

Shielding for the sound trap in the luminance detector circuit is taken care of by a small copper strip enclosing the trap on sides not adjacent to ground. Details of the shielding are shown in the photographs.

Before dip soldering, an epoxy resist is screened over the coils and coupling capacitors so that their values will not be altered during the soldering process.

The entire chroma detector circuit, including the bifilar T 4.5-mc sound trap L_t with sound take-off coil, is included within a $\frac{7}{8}$ by $\frac{7}{8}$ in. shield can except for the crystal diode.

Details of shielding for i-f amplifier show punched chassis containing spring surfaces for good shielding contact

A series tuner is used to check the performance characteristics. Sensitivity for 1 v d-c rise at the luminance detector load is 60 μv (i-f) for the mixer grid, 12 μv for channel 3 and 16 μv for channel 10.

Trap rejection of sound at the luminance detector is 63 db, adjacent sound is 58 db and adjacent picture is 40 db.

Adjacent picture attenuation could be increased to greater than 50 db by adding another trap. However, further shielding for this addition did not warrant the cost and the trap was left out as an economic compromise.

Roof-Top-Target Tubes

New pulsating X-ray tube designs and systems for their use are described. The most successful system uses two tubes. Each tube is controlled by applying a relatively low-voltage square wave to a special tube element called a diaphragm. Anode current is maintained constant by alternately switching from one tube to the other. Pulsating frequency can be controlled from 35 to 100,000 cps with an adjustable duty cycle from 10 to 90 percent

By **E. F. WELLER** Physics-Instrumentation Dept., Research Staff, General Motors Corp., Detroit, Mich.

SYSTEMS for using special X-ray tubes, which can be pulsed over a wide range of frequencies and duty cycles, are described. The tubes are capable of delivering therapeutic dose levels.

Square pulses of X-ray energy can be produced at rapid repetition rates in five basic ways. These are: interruption of the beam with a mechanically controlled shutter; pulsing the anode voltage of the X-ray tube; use of a control tube in the cathode circuit to interrupt the X-ray tube current; deflection of the electron beam, within the tube, to a second target which emits X-rays in a different direction; and interruption of the X-ray tube current by pulsing a control element within the tube. The first three systems limit duty cycle and/or repetition frequency. The remaining two do not.

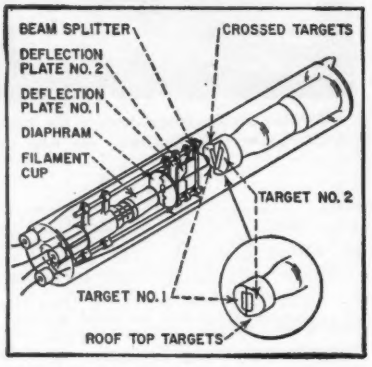


FIG. 1—X-ray tube, type 1, has crossed targets. Type 2 has a roof-top target

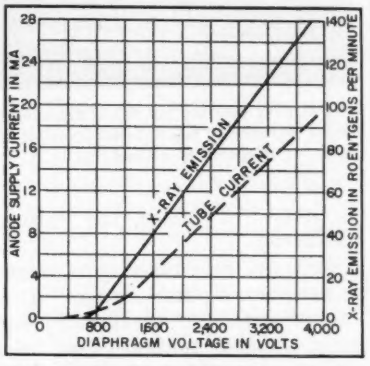


FIG. 2—Cutoff characteristics of the second X-ray tube described in this article

Table I—Typical Characteristics of Pulsating X-Ray Tubes

	Experimental Type 1	Experimental Type 2
Anode voltage (kv)	+80	+80
Anode current (ma)	20	20
Deflection plate voltage (v)	+1,200 − (+50)	+1,250 − (+60)
Beam splitter and diaphragm voltage (v)	+1,250	0
Cathode bias (v)	−800	−2,000
Filament voltage (v)	8	8
Filament current (amp)	4	4
Output (r/min at 10 in.)	240	230
Tube dimensions	20¾-in. long	4-in. diameter
Distributed capacitance ($\mu\mu$f)		
Beam splitter and diaphragm	1.15	
Deflection plate	0.95	
Anode	not measurable	

To make possible electron-beam deflection and current-interruption systems, two basic tube types were developed and supplied by Westinghouse Electric Corp. Each tube type shown in Fig. 1, contains a special target shape, electrostatic deflection plates, and a diaphragm or grid. Output from both tubes, as well as operating voltages and currents, are shown in Table I.

Beam-Deflection System

The electron-beam deflection system, using the new tubes, presented one basic problem. The total number of electrons comprising the tube current could not be directed solely to the desired target. Under optimum conditions, a minimum of three percent of the X-rays was emitted from the dead target. This emission was probably caused by stray electrons striking the target.

Experimentation showed that it was possible to cut off the X-ray tube current completely by reduction of potential between diaphragm and cathode. Tests run with fixed deflection-plate voltage and a pulsed diaphragm voltage showed that this type of operation was feasible. Figure 2 shows cutoff characteristics of the second experimental tube type when operating under these conditions. Experience with the tubes indicated that the diaphragm voltage required to cut off the beam current could be reduced by a redesign of the location of the tube elements.

Pulse X-Rays

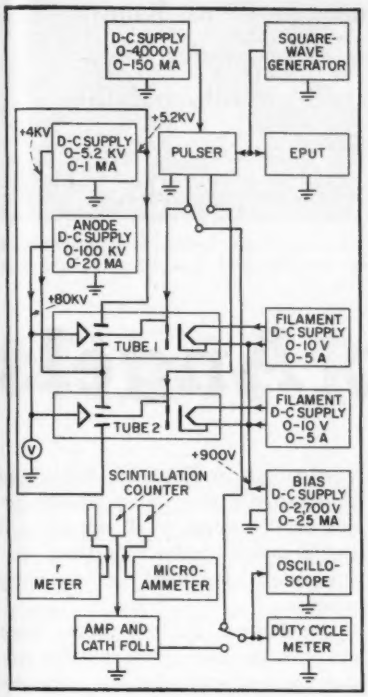


FIG. 3—Ultimate system uses two, type-2 tubes. Principal components are shown

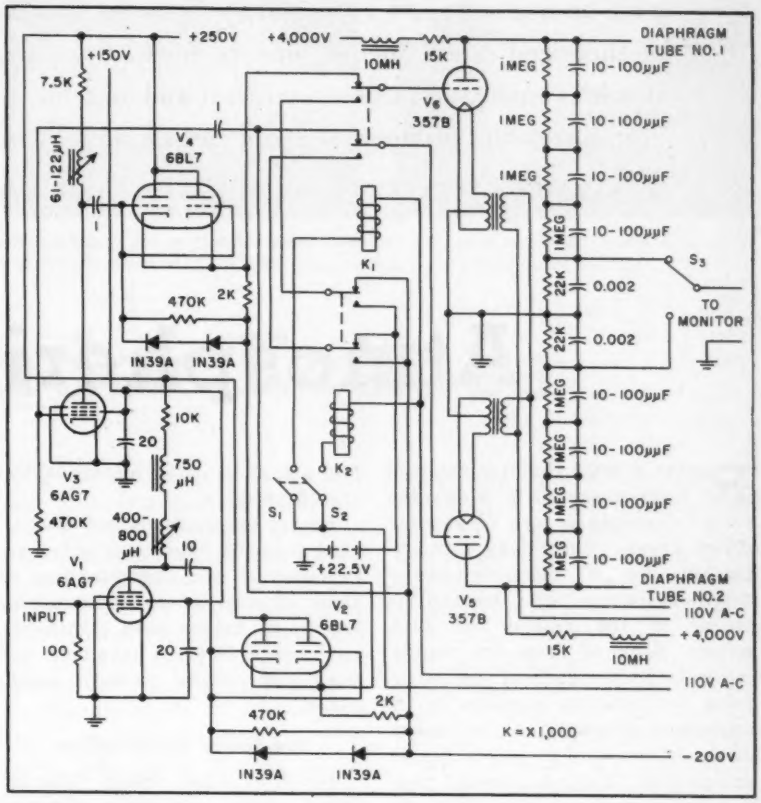


FIG. 4—Diaphragm pulser circuit. High-voltage pulses are generated in this unit

Since average anode current is a function of duty cycle, constant anode voltage is difficult to maintain with commercial X-ray high-voltage supplies. Commercially available power supplies are not capable of holding the instantaneous tube output sufficiently constant. This difficulty was overcome by installing a second X-ray tube. The diaphragms in each tube were pulsed alternately to maintain constant anode voltage and current.

Final Two-Tube System

The overall pulsating X-ray system is shown in Fig. 3. Electrode power-supply voltages were designed to pulse the diaphragms. From a circuit design and construction viewpoint, it is easier to make the pulser and high-voltage supplies operate with their negative voltage sides at ground potential. This factor complicated the anode cooling problem in that the anodes are operated at 80 kv above ground.

The tubes are constructed without an outer protective cover or tube housing primarily so that the tube elements can be observed at all times. As a result, a cooling liquid could not be circulated over the surface of the tube. Cooling is accomplished by circulating water through a spray nozzle screwed into the anode stem behind the target.

The pulser must supply 3,600-v peak-to-peak pulses, swinging from 400 to 4,000 v. It derives its input signal from a square-wave generator modified to give an adjustable duty cycle of 10 to 90 percent from 35 to 100,000 cps.

Pulser Circuit

Circuit diagram for the pulser is shown in Fig. 4. Tube V_1 is a voltage amplifier with the plate peaking inductance adjusted for optimum operation. Output of this stage drives a cathode follower, V_2, which provides sufficient power to drive one of the pulser tubes. A signal from V_2 is also coupled to a phase inverter, V_3. The phase inverter feeds cathode follower V_4 which drives the other pulser.

Grids of V_2 and V_4 are diode-clamped to keep the baseline of the waveform at constant level. Output from stages V_2 and V_4 is fed to relay K_1. This relay permits switching grids of the 357B pulser tubes from the output of the cathode followers to steady direct voltages. The voltages are set so that one tube has +22.5 v applied to its grid while the other has −200 v. Actuating relay K_2 reverses this condition to permit either steady-up or steady-down X-ray beam operation.

Diaphragm drive tubes, V_5 and V_6, are inductively compensated in the plate circuit. The 357B tubes were chosen because they develop high-voltage pulses and their interelectrode capacitances are small.

Spurious indications on a radar screen of an object in space when nothing is visible are commonly called angels. Observations of reflection phenomena have been noted since 1936 and up to recent flying saucer incidents. Known or theorized causes include insects, birds, tropospheric layers, water vapor, storms, convection bubbles, mineral and organic particles, clouds and the ever increasing number of radio signals present in space

By VERNON G. PLANK Project Scientist, Air Force Cambridge Research Center, Bedford, Mass.

Atmospheric Angels

RADAR ECHOES that are received from or caused by a sensibly clear atmosphere are commonly called angels. Coincident with expanded use of ultra-high-power radars there has been a marked increase in the number of such echoes. Some of them are readily recognized as products of scattering from precipitation particles or of anomalous propagation, but many of the others tend to defy a simple explanation. They are mostly phenomena of mere casual interest, but they can cause operational problems and are of growing meteorological significance.

Recent observations and accelerated research have contributed appreciably to our understanding of these elusive echoes. Controversy has by no means been eliminated, but certain features have been isolated and general patterns established.

Pre-Radar Observations

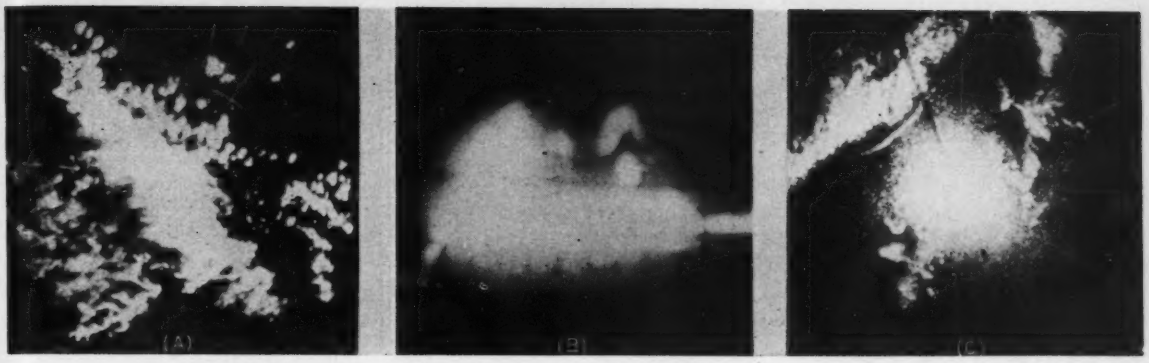
The first angel echoes were detected with vertically directed pulsed radio equipment. In 1936 investigators in England, India and the United States independently reported detecting weak echoes at 3 to 300 meters under conditions that suggested low-level atmospheric sources.

Continuing pulsed radio work prior to the war supported the initial observations. Echoes were detected frequently at altitudes of 1,600 to 50,000 ft during all seasons and at various hours of the day and night. They tended to be especially strong in summer, during the afternoon and near the tropopause below 8,000 ft. The altitude of the sources appeared to vary with air mass and at times echoes that were strong and persistent at 25 and 50 meters were weak and intermittent at 3 meters. Maximum power-reflection coefficients varied from 10^{-6} at long wavelengths to 10^{-10} at the shorter ones.

Considerable controversy existed concerning the source of these echoes. Pulsed radio antennas were at best only slightly directive, and many persons felt the echoes were merely side reflections from ground objects. Others considered the sources to be refractive layers or patches, primarily because of the many correlations between the occurrence and altitudes of the echoes and the meteorology.

Strong echoes, for example, were received from altitudes where radiosonde and aircraft measurements showed the presence of

FRONT COVER—Radar weather station at Milton, Mass. has four radars operating from 0.86 to 3.2 cm. has observed many of the angel echo phenomena



Radar displays of several angel types. Lower left section of (A) is lightning echo. Circular echo under inverted-U mantel echo of (B) was rising at 250 ft/min. Thin diagonal line in upper left region of (C) is echo from clear sky just ahead of squall line

Mimic Radar Echoes

weather fronts, air-clound boundaries and other strata having sharp and extensive lapse rates of relative humidity, the refractive index being highly dependent on humidity. Weak and more diffuse echo types were observed with turbulent zones and thunderstorms. Ion layers were suspected for a time, but measurements disproved this possibility.

Various attempts were made to resolve this controversy but general agreement never was reached. The observations are nevertheless most interesting when viewed in the light of subsequent radar observations of similar phenomena.

Layer Echoes on Radar

Echoes from suspected tropospheric layers or patches were first detected on vertical-pointing radars in 1947. Equipment operated at 10 cm and radiosonde data showed that the echoes derived from altitudes where atmospheric refractive layers existed. Other echoes were observed at 3 cm and 13-17 meters as well.

Subsequently at the Cavendish Laboratories, low-level echoes at 10 cm were detected over Cambridge, England, and a detailed meteorological study showed that they were from an atmospheric subsidence inversion. Evans Signal Corps Engineering Laboratory, using a 0.86-cm vertical-pointing radar, received a semicontinuous echo for a 20-hr period from the clear sky near a sharp subsidence inversion. Air Force Cambridge Research Center detected well-defined signals from a sea-breeze front 800 feet above a 1.25-cm radar and many echoes from invisible layers and thin stratified clouds were observed using S-and L-band equipment.

Although there is little doubt that atmospheric layers can give radar echo, rigorous proof of the point is beyond our present capabilities. The echoes are a product of the microrefractive structure of the stratified or turbulent layers. We can neither measure this structure to the resolution required nor can we obtain from present theory more than a qualitative idea of the scattering or partial reflection to be expected. Present instruments having a resolution capability of a few feet do show many regions and layers where refractive-index gradients are sharp and extensive.

Project Lincoln of Massachusetts Institute of Technology has made various airborne-refractometer measurements and found numerous stratified refracting layers. Some extend over many square miles and possess vertical gradients of as much as $3N$ units per meter. Quantity N is $(n-1) \times 10^6$, where n is the true refractive index.

It has also been shown theoretically that such layers can cause significant partial reflection of meter and centimeter waves, a given layer being more reflective at the longer wavelengths. AFCRC has measured 40 to $70N$ unit changes in tens of feet at the top of a stratus cloud deck and flying through a warm front has revealed it to be a region of considerable index variation.

Some radar echoes may look like atmospheric layers but merely be side-lobe reflections. Site, antenna pattern, type of scan and set sensitivity and power are determining factors. High power radars can be especially subject to such reflections, for although the side lobes are 20 to 30 db below the primary they radiate substantial power.

Wind-Carried Sources

In 1943 a different type of radar echo phenomena was noted by Bell Telephone Laboratories. Invisible and apparently wind-carried sources in the lower troposphere were causing transistory and sharply localized echoes on sensitive X- and S-band equipment. On a plan-position scope the echoes take the form of dots or small areas moving over the face, sometimes in tremendous numbers.

On a range-height indicator or the azimuth-range scope of a fixed-beam radar operating anywhere between horizontal and vertical incidence, the echoes are from a fraction of a second to several seconds duration, and frequently a number of them occur simultaneously at different ranges. Gener-

ally the echoes are received from ranges of less than 20 mi and their character is coherent, quite different from the scattered signals from precipitation. Most sources are indicated to be smaller than the resolution capability of the radar.

Many such echoes have since been detected, especially at Q, K and X bands. They are observed in all seasons, both day and night, but they are more likely to occur in summer and at midday. Warm, moist, clear days seem especially favorable. Maximum volume reflectivities at K and X bands range from 10^{-10} to 10^{-15}, which is about 0.4 to 50 sq cm radar cross-section.

The primary source of most of these echoes is believed to be refractive-index inhomogeneities of various types. Convective bubbles, highly refractive portions of atmospheric layers and water-vapor or temperature-anomaly regions are typical examples.

The precise mechanism of energy return from a variable dielectric is not known. But it is suspected that echo is the summation product of partial reflection from all the favorably-oriented refractive-index gradients or other microstructure within the radar pulse volume.

That which appears best to explain daytime activity is the convective bubble. Such invisible bubbles rise from the earth's surface during active solar heating and are important elements in cumulus-cloud development. The sharp refractive gradients in the upper and side-boundary region of the bubble are believed responsible for echoes. Aircraft and other observations verify the bubble's existence and theory forecasts their sharp boundary structure. Decided correlations between convective and angel activity have been noted by various investigators.

Insects are also important contributors. Their ability to cause substantial scatter signal on sensitive high-resolution Q- K- and X-band radars has been proven by theory and observation. Radar crosssections range up to four times geometric size and, since the system compresses a large part of the atmosphere onto a small indicator, surprisingly few insects can cause appreciable scope clutter.

On a 0.86-cm cloud-base-and-top indicator only one detectable-size insect in 10^6 cu ft is required to fill the scope with echo. Normal concentrations of large insects are perhaps ¼ to 1/6 of this, but during the spring and fall they may approach or even exceed it.

Occasionally large mineral or organic particles are carried into the air by winds or thunderstorms. When they are settling, these particles may also cause angel echoes.

Relative importance of the two primary sources depends on location, time of day and wavelength. Evidently inhomogeneities are more important in humid climates, during midday and at the longer wavelengths. Insects predominate in arid climates, toward evening and at the shorter wavelengths. Since insects cause echo by scattering, considerable radiated power is required for their detection. Most operational X-, S- and L-band radars should therefore be free of insect echoes.

Mantel Echoes

Another wind-carried echo source was isolated quite recently. Echoes that defined the general upper and side boundary regions of small cumulus clouds were received on S band at East Hill, England. The clouds were nearby and clearly visible, and a perfect correspondence was established between the echo and cloud positions. On the rhi scope these mantel or cap echoes look like inverted U's and V's. Similar echoes have subsequently been observed on Cape Cod, also at S band. Both observations failed to detect the echoes at X band.

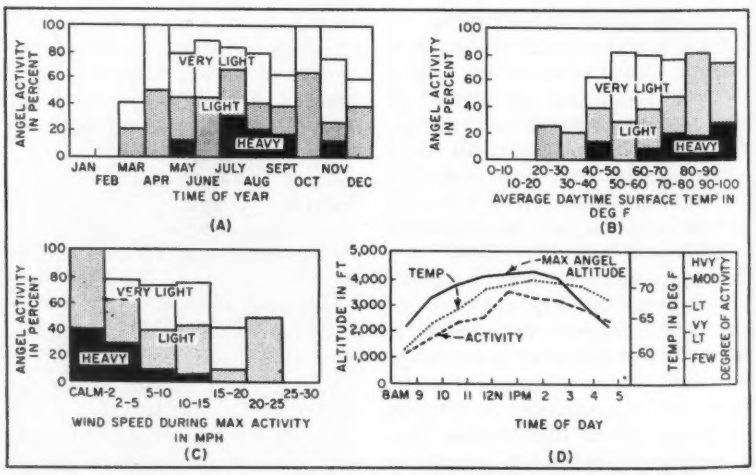
It is believed that mantel echoes are caused by scattering or partial reflection from sharp and extensive refractive-index gradients that airborne refractometer measurements have shown to be in the boundary regions of cumuli. These echoes couldn't have resulted from scattering by water droplets as the clouds were too small.

The East Hill observations also revealed other angel echoes rising into the cumuli from the clear air region below, and sometimes columnar echoes were observed extending from the ground to the mantels. Implications are that the radar was seeing convective bubbles and thermals.

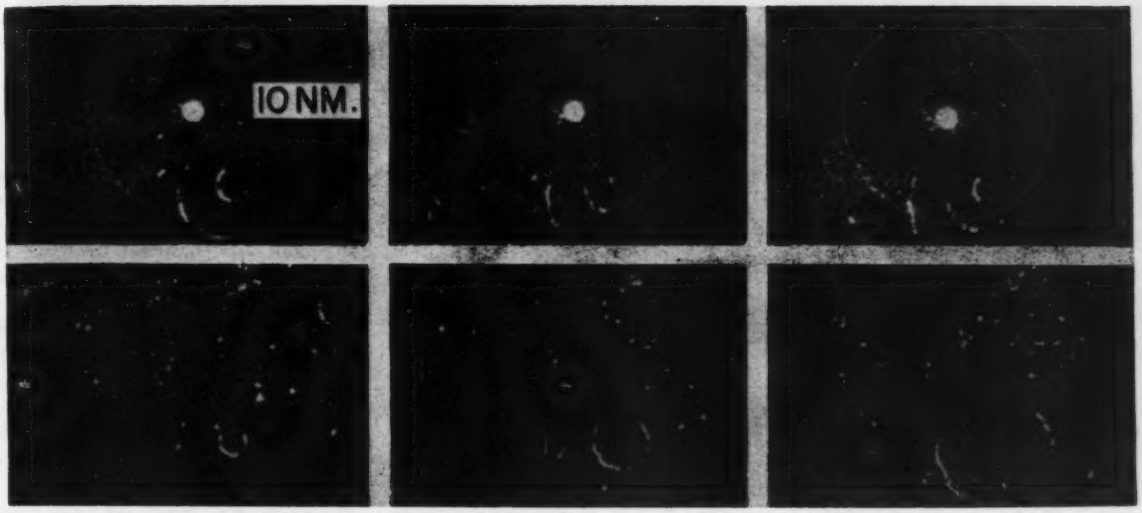
Non-Wind Echoes

There is also a class of localized angel activity similar in scope appearance to that apparently from wind-carried sources except that the echo movement may vary from the wind velocity and direction. Velocities are generally under 50 knots, movements are semiregular and the tracks are smooth curves. Some reports, however, indicate movements in the direction of the wind at twice its velocity. Radar cross-sections of the sources range as large as 700 sq cm at L band.

Such angels have been observed primarily on air-traffic-control ra-



Seasonal variation of angel activity (A), variation with temperature (B), with wind speed (C) and diurnal variation (D)



Ring angels observed on two January days at Engineering Research Institute of University of Michigan. Sightings occurred around 4 p.m. local time and were observed on a 23-cm FPS-3 radar

dars with the ppi scan and moving-target indicator on. They strongly resemble echoes from small aircraft and usually occur at a range of less than 20 mi. They sometimes are so prevalent as to constitute a definite operational handicap. Radars seem most strongly affected in the L band, but the echoes are also common at S band and have been reported at X band. On several occasions the sources have been followed with a tracking radar for 20 min.

Suggested sources for most of this activity include birds, larger insects and elevated refractive-index inhomogeneities. Reports of bird echoes date back to 1939. Birds are excellent scatterers and at close range can cause substantial echo.

In 1945 the British Army Operational Research Group made an extensive study of bird echoes and measured radar cross-sections as large as 20 sq cm at S band. More recent measurements show that sea gulls scatter energy as though they were airborne quarts of water. Large birds at 10 mi will give signals equivalent to that from a medium-size aircraft at 50. Even the fading-fluctuation character of the echoes resembles that of aircraft echoes.

Project Lincoln and the Naval Research Laboratory have reported that birds are almost wholly responsible for the angel activity observed near the Atlantic shore in mid-latitudes. Echoes in varying number, depending upon day and location, have been observed out to ranges of 20-25 mi. Visual observations have agreed with indicated source positions and the velocities and motions were appropriate to birds. Furthermore the presence and patterns of activity conformed with many of birds' characteristic habits. Reports point out the excellence of bird sources because of their elevation above the surface, and emphasize that as few as eight birds in a sq mi can completely blank the ppi.

Although birds probably predominate as sources of non-wind-correlated angels, they cannot explain echoes with indicated radar cross-sections of several hundred sq cm. There must be other sources. One hypothesis is that they are elevated refractive inhomogeneities which play a different role from those described previously. Here they are visualized to be properly-structured and oriented blobs, or convective bubbles.

Or they may be portions of atmospheric layers which divert incident radar energy to the ground by refractive bending or forward scattering. The illuminated patch of ground, perhaps a particular terrain feature, then scatters energy back to the receiver through the reciprocal path. The situation is really anomalous propagation, but only a few small atmospheric volumes are involved.

There is appreciable evidence to support the hypothesis, and it is easier to explain echoes from inhomogeneities if we assume diversion to ground rather than direct back scatter. That anomalous propagation can result from convective blobs on a clear day is not commonly known, yet this was recently observed and verified on 3 cm at Salina, Kansas.

Other possible explanations for non-wind echoes are side-lobe and second-sweep, automobile reflections, interference between radars, and instrument-produced signals.

Rapid and Erratic Movements

A type of nonaircraft echo suddenly appears, moves for some minutes in a semi-straight line path at 600 to 1,500 mph and then disappears. As yet this is unexplained, but there is speculation that the source might be shock waves, echo being the product of direct backscatter or diversion of energy to ground. Shock waves are thin, on the order of 10^{-5} in. and the refractive index differences across them can range as large as several hundred N units.

Then there are radar flying saucers. One popular explanation invokes extraterrestrial sources, but others can also be conjured. There is good reason to believe that

many such echoes are merely the product of scope misinterpretation. The observer assumes that the echo return presented on successive rotations of the antenna is derived from a single moving source when actually the returns are unrelated ones of types previously discussed. The classic saucer incidents over Washington, D. C. in July, 1952, for example, occurred when the atmosphere was exceedingly superrefractive and spotty anomalous propagation was definitely in order.

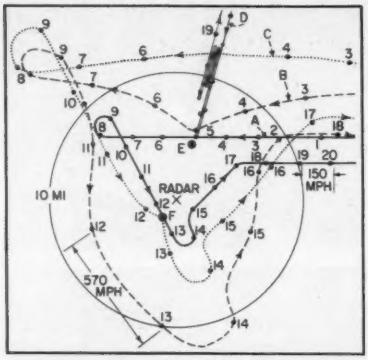
Another saucer mechanism that could explain rapid and erratic echo maneuvers at close range is non-isotropic secondary-scattering of energy from aircraft to ground or the inverse. Phantom echoes that overtake, fly parallel with or collide with valid aircraft echoes can be thus explained.

Other scope patterns reveal phenomena with rather obvious meteorological origins. In the summer of 1953 sea breeze fronts were detected at horizontal and vertical incidence as they moved onshore at Round Hill, Massachusetts. During 1955-56 ring angels were detected at Ann Arbor, Michigan. These appear on the ppi like concentric, expanding waves formed by dropping a stone in water.

The mechanism best explaining the facts is that radar energy was diverted to ground by elevated, point-source gravity waves. Lines or bands of angel echoes have frequently been observed at L and S bands lying in the clear air regions in advance of squall lines or parallel to the edges of shower echoes. Frontal circulations set up by storms or nascent zones of cumulus development are believed responsible. Finally there have been many observations at X, S and L bands of the ionized channels left in the atmosphere by lightning discharges.

Meteorological Angel Study

Our knowledge of the seasonal, diurnal and general meteorological dependence of most angel types is exceedingly sketchy. Certain associations with convection, non-conventional superrefraction and with clouds and fronts have been noted rather frequently. But the specific dependencies have not been established, nor the forecast rules ascertained. We know that small cumulus clouds don't invariably produce mantel echoes and that convection occurs frequently without angels, but we have as yet only identified a few of the peculiarities of the meteorology that are responsible for the differences.



Echo from secondary scattering. Line *A* is aircraft path, line *B* is echo from aircraft to point *E* to aircraft to receiver. Line *C* shows similar scattering involving point *F*. Line *D* shows scattering from *E* to aircraft to *E* to receiver

The angel activity observed on a vertical-pointing radar operating at 1.25 cm, with 0.37 deg conical beam, 0.4-μsec pulse and 10.8-kw output has been studied in some detail and may be typical of the activity of apparently wind-carried sources. Facsimile records of the a/r scope for a 15-month period of daytime operation were analyzed to ascertain the nature of the angel activity and sources. Days both with and without echoes were compared with the meteorology. The radar site was Boston.

The investigations reveal that angels occur primarily on days with high temperature, high humidity and low wind speed. Activity is especially intense during the summer months, at midday and with clear skies. Activity also appears to be favored by opposing conditions of surface and atmospheric moisture. No angels have occurred when the ground is completely covered with snow, when low-level atmospheric temperature inversions exist below the minimum radar range of 500 ft, or when the atmosphere is extremely dry.

In most instances angels occur entirely within the convective mixing region, sometimes showing an obvious intimate correlation with cumulus clouds. On clear days there is a pronounced diurnal trend, echoes beginning early in the morning, increasing to maximum at noon, then decreasing rather sharply during the afternoon. The echo altitude rises throughout the morning, is highest at the time of maximum surface temperature, and drops off thereafter.

Bunched or layer echoes occur in the vicinity of sharp moisture gradients, with or sometimes immediately after a summer rain, or under conditions of extremely high moisture, with greater than 12 gm of water vapor in one kg of air. Calculations indicate that the echo sources range up to 70 ft wide and from 180 to 360 ft high, with the smaller sources more numerous.

Available entomological information indicates insect and angel activities to be similar in many respects, and insects appear to be an important source of echoes. With few exceptions, however, insects do not fly at temperatures below 40 or above 95 F. Substantial angel activity is observed on both sides of these limits. Furthermore, indicated source sizes of some tens of feet are not readily explained by insects.

Meteorological conditions favoring atmospheric refractive inhomogeneities and the theoretical refractive properties of nonsaturated air parcels rising through a turbulent environment have been established. The observed seasonal and temperature dependence of angels agrees with the theoretical conditions favoring refractive inhomogeneities. Virtually every observed feature of the activity is explained if one assumes that the responsible inhomogeneities are convective bubbles of warm-moist air.

But the full potential of radar techniques for studying fronts, inversion, lightning activities and the processes of convection are just beginning to be realized. Vertical probing at L and P bands should enable us to detect and monitor their positions and thus obtain information not presently available from weather radars that depend on particle scattering for signal.

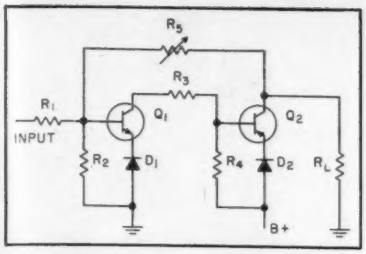


FIG. 1—Basic transistor relay circuit is controlled by Zener diode D_1

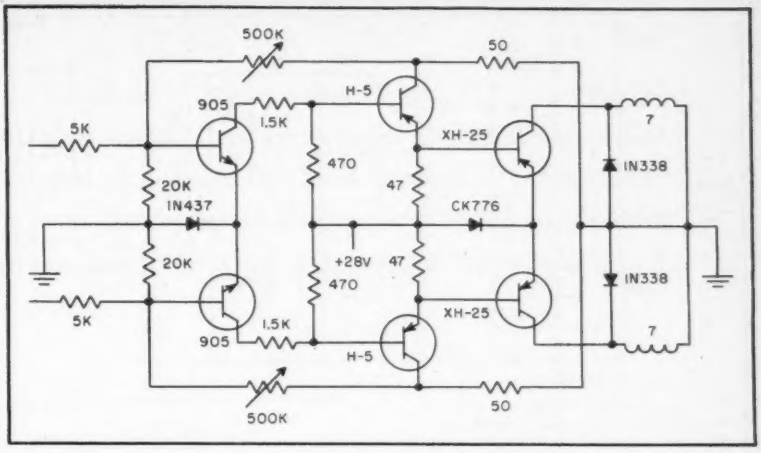


FIG. 2—Push-pull relay capable of handling 10 amperes has high-speed response

Fast Transistor Relay

Push-pull switching unit capable of handling up to 10 amperes has a rise time of 50 μsec. Zener diode control triggering voltage level to eliminate need for step-waveform control voltage to provide equivalent to mechanical relay

By **DORRANCE L. ANDERSON** Development Engineer, Army Ballistic Missile Agency, Huntsville, Alabama

TRANSISTORS prove to have almost ideal switching characteristics. However, to obtain the step function characteristics of a closing relay with transistors a step function is usually necessary at the input of the transistor.

In the circuit described here, a step input is not required yet switching is as rapid as with a relay.

A rising d-c voltage applied to the input produces no output until a predetermined level has been reached. Upon reaching the desired input level, the power-supply voltage is suddenly switched across the load. The circuit remains locked in as long as the input voltage equals or exceeds the level at which the trip action takes place.

The transistor relay circuit is shown in Fig. 1. Key to its operation is controlled positive feedback. The input voltage at which the circuit trips is determined largely by the breakdown voltage of Zener diode D_1. Fall-out voltage is controlled mainly by the breakdown voltage of the diode and the amount of positive feedback.

Circuit Operation

As the input voltage reaches the level where D_1 begins to break, current starts to flow in the input circuit of Q_1. Collector current of Q_1 drives Q_2 into conduction. The collector of Q_2 goes positive and this positive-going voltage is fed back through R_5 to the base of Q_1. This feedback is regenerative and drives the circuit to saturation thereby switching the supply voltage across the load. This action takes place in a matter of microseconds, depending on the rise time of the transistors.

It is important that the Zener diode have a sharp break. Diodes that break at about seven volts are recommended for this application. Resistors R_1 and R_2 form a voltage divider and isolating network for Q_1. Resistor R_3 is a current limiting resistor for the protection of Q_1. Resistor R_4 provides a relatively low impedance from base to B + of Q_2 for stabilizing purposes. Diode D_2 offers high impedance from emitter to ground of Q_2 when Q_2 is not conducting. This protects the transistor against thermal runaway at high ambient temperatures. Once the circuit trips, D_2 becomes a low impedance and offers little inverse feedback.

The circuit shown in Fig. 2 performs as a push-pull relay capable of switching 4 amperes at 28 volts. A single 1N437 silicon Zener diode serves both sides of the circuit producing better balance than if separate diodes were used. The H-5 transistors switch approximately 0.5 ampere to drive the XH-25 transistors to 4 amperes output. The diodes across the output are used with inductive loads to protect the transistors from inductive spikes. The diode common to the emitters of the output transistors is for stabilizing purposes at high ambient temperatures. System rise time is about 50 μsec compared to several millisec delay time for mechanical relays.

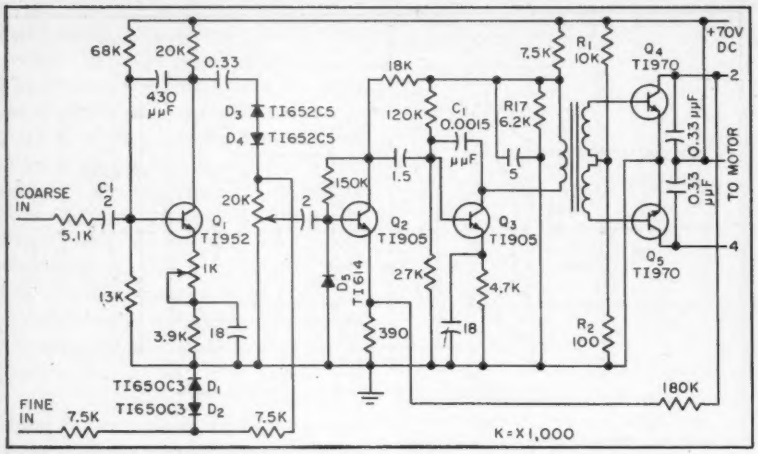
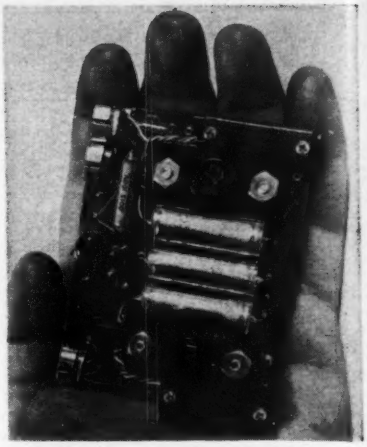


FIG. 1—Silicon transistors and diodes ensure reliable operation in extreme temperatures. Maximum coarse and fine signal input is 26 volts rms at 400 cps. Voltage gain of coarse amplifier Q_1 is about 25 and that of feedback amplifier Q_2, Q_3, Q_4 and Q_5 is 460



Transistorized servo amplifier can be held in palm of hand. Amplifier contains five transistors and four Zener diodes

Direct Drive Amplifier

TWO-SPEED TRANSISTORIZED servo amplifiers are constantly increasing in usage. The system described consists of an input switching circuit, which selects the proper signal with respect to the mechanical error, and a three-stage feedback amplifier capable of directly driving a standard size-11 motor.

Coarse and fine inputs are designed for maximum signals of 26 volts rms at 400 cps and both have an impedance of at least 10,000 ohms. Voltage gain from the fine input is adjustable from 0 to about 460 at 400 cps. The input switching circuits are designed for a gear ratio of 45 to 1 between the coarse and fine synchros. However, redesign for other ratios is possible. A complete servo amplifier circuit is shown in Fig. 1. Gain characteristics are as in Figs. 2 and 3.

Input Switching Amplifier

Figure 4 illustrates the relative phase of the coarse and fine inputs at the time of switching. The two voltages shown are the magnitudes of the 400-cps outputs of two control transformers as the two-speed system approaches a null. Switching must occur to the left of point *A* to prevent a 180-deg ambiguity in the null position.

Ideally, the gain from both coarse and fine inputs should be constant to maintain constant system gain. This is accomplished by inserting an amplifier between the coarse input and the main amplifier, since the fine input is geared up and thus has higher loop gain. Since the fine signal is attenuated to 0.57 of its original value by a resistance divider, gain needed in the coarse amplifier is roughly 0.57 times 45.

Actual switching of signals is accomplished by Zener voltage reference diodes D_2 and D_1 (Fig. 1) connected back-to-back in series with the output of the coarse amplifier.

The inputs should switch when the coarse voltage is about 0.2 volts rms. This represents 5 volts rms at the amplifier output, so the 6-volt diodes, TI 652C5, should perform satisfactorily.

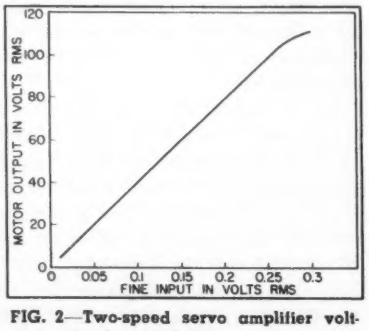


FIG. 2—Two-speed servo amplifier voltage gain characteristics

After switching to the coarse input, the fine signal must have as little influence as possible. Since transistors operate with relatively low maximum collector voltages, their maximum rms output is severely limited. A TI 952 was chosen as coarse amplifier Q_1 for operation with the +70-v d-c supply to obtain optimum output. Limiting of the fine signal was necessary to reduce mixing effects at the main amplifier.

Two Zener diodes D_1 and D_2 are used as clippers at the fine input, and the limiting voltage is arranged so that the coarse input takes control before limiting of the fine signal begins. This preserves linearity at small error angles.

An unbypassed variable resistance in the Q_1 emitter circuit provides gain adjustment.

Feedback Amplifier

Forward voltage gain of the three-stage amplifier is about 5,000 and feedback from the output to Q_2 emitter reduces this to 460. Large amount of feedback used makes the gain quite stable over a wide range of temperatures and with wide variations in transistor

Five-transistor servo amplifier directly drives standard size-11 motor, eliminating need for an output transformer. Used in two-speed systems, amplifier contains a switching circuit and three-stage feedback network. Switching between fine and coarse signals is accomplished by Zener diodes. Large amount of feedback stabilizes voltage gain over wide temperature range and broad transistor parameter variation

By B. E. ORR

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For Two-Speed Servos

parameters. Figure 5 shows gain variation over the range of −20 to +100 C, with a nominal gain of 400 at room temperature. Electrolytic capacitors used in the prototype are designed for an upper limit of 85 C. Consequently, the portion of the gain curve above that temperature represents only what would happen if the amplifier were subjected to high temperatures accidentally.

Sufficient voltage derating of the capacitors allows the extreme temperature to exist for several hours if necessary without impairing the voltage gain of the amplifier. Higher-temperature electrolytics now becoming available promise a substantial increase in the maximum temperature rating. Dissipation of all transistors in the circuit is sufficiently low to allow operation at up to 100 C.

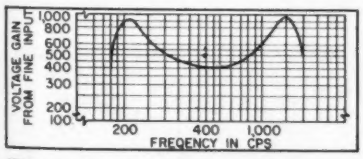


FIG. 3—Two-speed servo amplifier voltage gain-frequency characteristics.

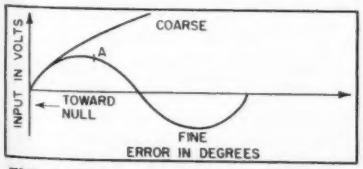


FIG. 4—Phase error voltage relationship between coarse and fine signals in the two-speed servo system. Switching between two signals should occur to the left of point A

The two voltage amplifier stages Q_2 and Q_3 are conventional. Diode D_5 at the base of Q_2 is necessary to prevent the base voltage from reversing at high input signal levels. High-frequency oscillations are eliminated by capacitor C_1 from collector to base of Q_3. Collector supply for Q_2 and Q_3 is obtained from a voltage-divider network that supplies about 25 v d-c.

Maximum rms voltage developed at the motor is limited by the 120-v peak collector voltage rating of the 970. For the push-pull amplifier, the peak-to-peak load voltage is 200 to 230 v, or 78 to 82 v rms. This value is exceeded somewhat in the actual amplifier because of motor-load tuning. An actual rms voltage of 100 to 110 v is normally developed at the motor under no-load conditions. Choice of collector supply voltage was also based on the 970 peak voltage rating since each collector swings above and below the supply voltage by an equal amount due to the balanced load.

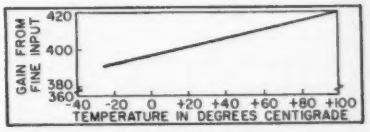


FIG. 5—Two-speed servo amplifier voltage gain-temperature characteristics. Gain at room temperature is about 400

A nominal supply of 70 v d-c prevents large excursions of the collector-to-base voltage into the Zener region where the dissipation per cycle would be high. Resistors R_1 and R_2 furnish a small positive bias of about 0.7 v d-c for the base circuit of the 970. This bias prevents crossover distortion in the class-B amplifier and considerably increases voltage gain over the zero-bias condition. Type 970 transistors used should have beta values within ±20 percent of each other, measured at 20 ma collector current, for proper circuit operation.

Bibliography

How to Design Speed Switching Circuits using Nonlinear Elements, *Control Eng*, p 50, Nov. 1954, and p 34, Dec. 1954.

A Diode's Zener Voltage Suits it for Two-Speed Data Switching, *Control Eng*, p 92, Jan. 1956.

W. R. Ahrendt, "Servomechanism Practice," Ch 4, McGraw-Hill Book Co., Inc., New York.

Servo Amplifier Uses Silicon Power Transistors, ELECTRONICS Jan. 1956.

F-M Exciter for Sight or Scatter Systems

Capable of operation in either a tropospheric scatter system or standard uhf line-of-sight communication systems, exciter accepts multichannel output of the telephone terminal equipment as a modulating signal and produces an output power of 15 w from 700 to 1,200 mc and 8 w from 1,700 to 2,400 mc. Unit handles 132 voice channels in addition to order-wire system

By A. E. ANDERSON and H. D. HERN Research and Development, Collins Radio Co., Cedar Rapids, Iowa

INCREASING DEMAND for high quality, long distance communication systems has necessitated the development of reliable, high-performance radio equipment. From the standpoint of system simplicity, flexibility and economy, uhf radio equipment applicable to both line-of-sight and scatter systems is highly advantageous. Interchangeability has special significance in satisfying the ever increasing logistic demands of the military organizations.

The uhf exciter to be described is applicable in either line-of-sight or scatter systems and has a minimum power output of 15 w from 700 to 1,200 mc or 8 w from 1,700 to 2,400 mc. It can be used either to provide excitation for a scatter-system power amplifier, or as a line-of-sight transmitter.

Frequency stability, noise and distortion level, frequency response, channel capacity, frequency coverage and power output are necessary considerations of the system in which the equipment is to be used. Since requirements vary from system to system, it is necessary to design for the most stringent anticipated conditions. In addition, reliability and service life, stability of tuning adjustments, ease of maintenance and simplicity of operation are desired.

Exciter Description

A general block diagram of the exciter is shown in Fig. 1. Functionally, it consists of four main units in addition to power supplies, switch panels and other accessory items.

The modulating input signal is separated into order-wire and multiplex spectra. The multiplex spec-

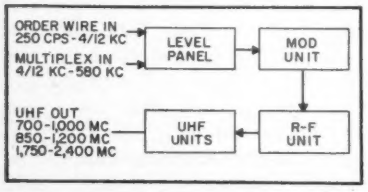


FIG. 1—Exciter consists of four blocks plus power supplies, switching panels and accessories

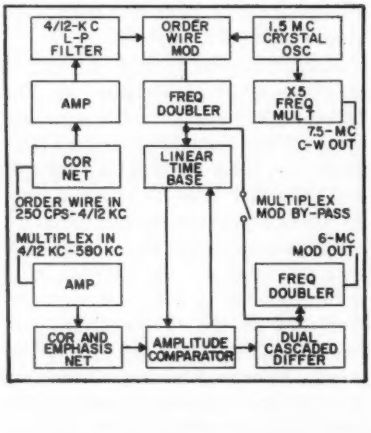


FIG. 2—Frequency-doubled carrier controls a linear time base in the modulator

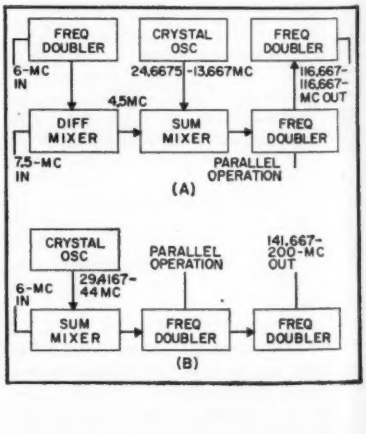
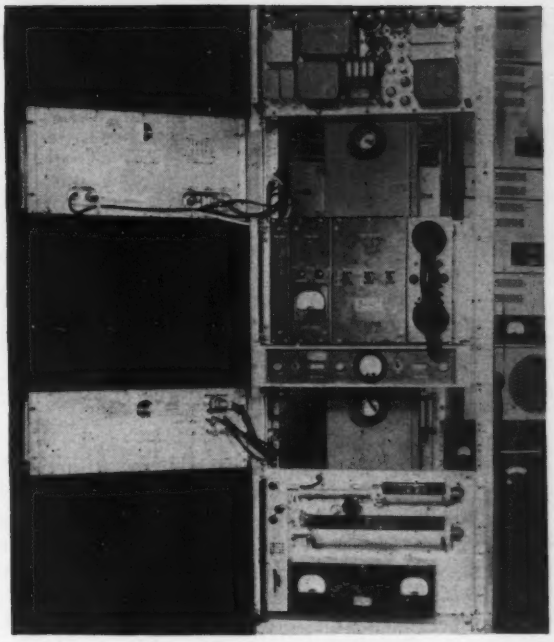


FIG. 3—Modulator outputs feed r-f units which cover 700-1,000-mc band (A) and 850-1,200-mc and 1,700-2,400-mc bands (B)

Authors operate f-m exciter in laboratory test to determine just how it fulfills design expectations



Dust covers are removed from exciter and two chassis are hinged out to show cabling and air connections

trum, consisting of the combined multichannel output of the telephone terminal equipment, starts as low as 4 kc and extends to an upper limit determined by the voice-channel capacity. The order wire consists of a voice service channel extending from 250 cps to 4 kc.

When the multiplex band starts at 12 kc or higher, the band from 4 kc to 12 kc is utilized in the order-wire circuit as a telemeter channel for special signaling, teletype or other desired service.

Modulator Unit

To obtain f-m characteristics a correcting network whose output is inversely proportional to frequency must precede the phase modulator. The voltage level as a function of frequency then decreases at the rate of 6 db/octave at the modulator terminals. Thus, the voltage difference between a 250-cps signal and a 512-kc signal is 66 db.

Since a single-phase modulator capable of handling eleven octaves of corrected modulation signal with extremely low distortion compared to the highest frequency signal level is impractical, the modulating spectrum is separated and two phase modulators are used in cascade. Furthermore a simple order-wire modulator can be used as the distortion requirement on the order-wire circuit is generally much less than on the multiplex.

In most f-m systems some pre-emphasis is used at the transmitter together with a companion deemphasis network in the receiver. This partially compensates the noise characteristics of an f-m receiver and permits a nearly equal signal-to-noise ratio in each channel. Although the preemphasis reduces the signal-level difference between the high and low modulating frequencies, it is not sufficient to warrant use of a single modulator for high channel capacity systems.

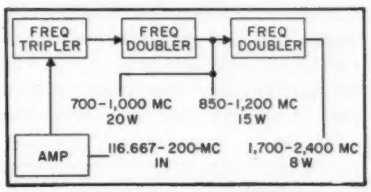


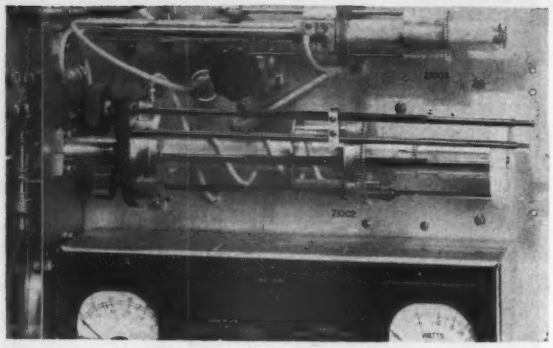
FIG. 4—Additional frequency-doubler circuit in uhf unit handles 1,700-2,400-mc band of the exciter

A 1.5-mc stable carrier is generated in the modulator of Fig. 2 and coupled to the conventional transconductance order-wire modulator and a factor-of-5 frequency multiplier. The phase-modulated output doubles in frequency and controls a linear time-base circuit. A diode instantaneously compares the multiplex signal level to the linear time base. At the instants of equality, the comparator produces an abrupt change in both waveforms.

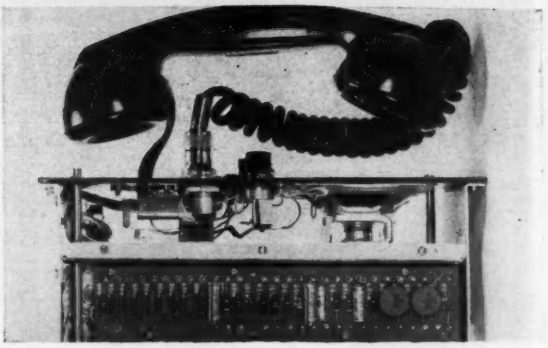
Two cascaded differentiators produce a narrow pulse whose position with time is proportional to the modulating waveform. The pulses control an amplifier whose output circuit selects a 1.2-mc band centered at 6 mc. The bandwidth is

TABLE I — Typical Operating on 700-1,200 MC UHF Unit

Stage	Amplifier	Tripler	Doubler
R-f input power	0.2 w	2 w	2.5 w
R-f output power	2 w	2.5w	15 w
Plate current	25 ma	30 ma	60 ma
Plate voltage	275 v	850 v	850 v
Bandwidth	2 mc	3 mc	6 mc



Closeup of uhf unit shows amplifier, tripler and doubler stages. Cavities are partially disassembled to show inner parts



Service channel portion of level panel with telephone handset indicates simplified modular construction

sufficient since the modulation index is low and the energy in sidebands beyond this range is negligible.

If the modulator fails in an installation having no standby, a section of the modulator unit can be bypassed, maintaining communications on the order-wire circuit.

R-F Units

A block diagram of the r-f units used to cover the 700-1,000, 850-1,200 and 1,700-2,400-mc bands is shown in Fig. 3. In the low-frequency unit of Fig. 3A a 4.5-mc signal is derived by using both outputs from the modulator unit and the 700-1,000-mc band is covered without objectionable spurious signals at the sum mixer output. Crystal frequencies in the r-f units are selected to obtain the desired final carrier frequency, thereby allowing the modulator crystal oscillator to be continuously operated at 1.5 mc. Common modulator and frequency-control circuits are required for obtaining coherent signals at two high-power transmitters. This is accomplished by bridging the two exciters at the parallel operation jacks and removing the oscillator crystal from either of the r-f units.

UHF Units

An amplifier, tripler and first doubler shown in the block diagram of the uhf units of Fig. 4 are used in all frequency bands. A second frequency doubler provides the 1,700-2,400-mc band output. The frequency multiplier stages consist of 2C39B ceramic triodes in coaxial resonators capable of continuously tuning to slightly less than a two to one frequency range.

Final carrier frequency is obtained in the uhf crystal-controlled f-m exciter of Fig. 1 by first heterodyning and then multiplying to the final frequency. The main advantage of this method is that full bandwidth is needed only at the output of the last multiplier.

The first stage of the 700-1,200-mc uhf unit shown in Fig. 5 is a grounded-grid amplifier. The plate is tuned by a one-turn inductor in conjunction with a 3-18.7-$\mu\mu$f variable capacitor. The second stage operates as a common-grid tripler and its plate is tuned with a coaxial resonator operating in the 1/4-wavelength mode. A lumped-constant π section matches the coaxial circuit to the cathode of the doubler stage. The plate circuit of the doubler is tuned by a coaxial structure operating in the 1/4-wavelength mode.

Since air cooling of the doubler and tripler stages is required, and the plate cooling fins extend from the cavity, the plates should be operated at d-c ground potential. The cathodes are at high negative potential.

Typical operating data of the unit is given in Table I.

The output power on all bands is continuously monitored by a resistive-loop directional coupler. A small portion of the output energy, 20 db below main-line power, is coupled out to obtain information for such functions as automatic switchover.

Level Panel

Figure 6 is a simplified block diagram of the level panel. The impedance matching network in the multiplex section provides connec-

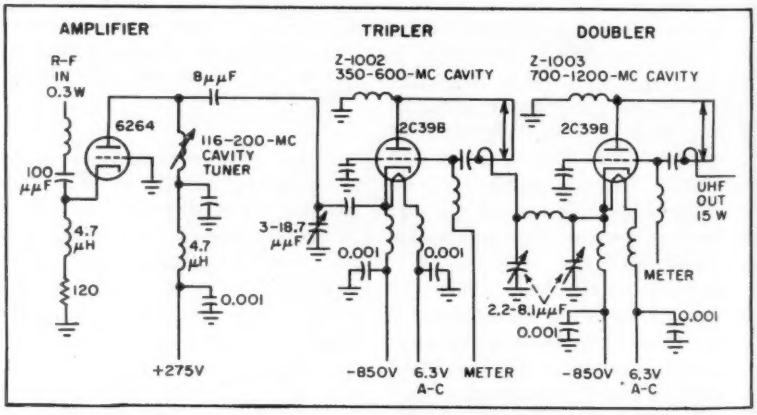


FIG. 5—Common-grid voltage tripler and voltage doubler of uhf unit are tuned with coaxial resonaters. Input coil for r-f has five turns of number 20 wire with 0.25-in. diameter

tion for 135/600 ohms balanced or single ended. The vtvm monitors the multiplex or order-wire circuit over a range of levels from −40 dbm to +10 dbm.

A party line feature on the service channel allows voice exchange from a link station. A 3.2-kc calling oscillator is used for service where external ringing is not desired. A 4-kc crystal-controlled oscillator is included for system continuity testing.

Exciter Performance

Transmission quality of a multichannel voice-communication system is normally expressed as a signal-to-interference ratio measured in each channel. The interference level consists of crosstalk products and noise introduced by the equipment and interfering sources. Such a performance measurement is generally made at a standard signal level and the interference level is expressed in dba units. Eighty-two dba is equal to one mw of noise measured with F1A weighting and referenced to a 0 db transmission level.

Since interference is generated in each portion of the radio equipment, all system components must be considered when designing a communication circuit. When evaluating a single system component, a figure for system quality can be expressed assuming all other components to be theoretically free from contributing to the channel interference level.

The interference level in the voice channel depends on the characteristic of the residual modulation present on the transmitted carrier. For the exciter described here the residual modulation introduces a 2 dba noise level at the −9 db transmission level.

In a single voice channel system a signal distortion level of some 10 percent or more can be tolerated before the intelligibility is greatly impaired. Unfortunately, such order of distortion is intolerable in multichannel systems because the high distortion produces objectionable crosstalk between channels. The crosstalk is at a maximum when the system is operating at the fullest possible capacity.

When the signals of many active voice channels are combined, the composite or multiplexed signal resembles random noise. Thus, if a measurement of distortion is made using random noise as the test signal, then actual multichannel operation is simulated.

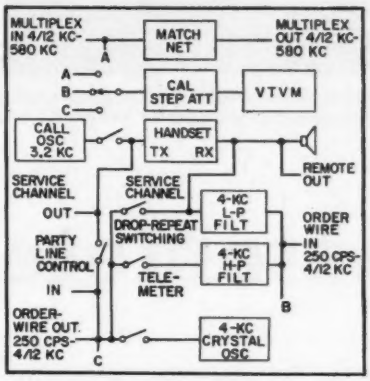


FIG. 6—Party-line feature on service channel in level panel permits voice exchange between link stations

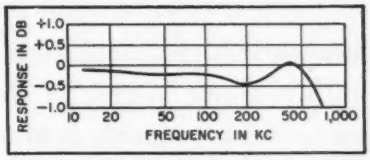


FIG. 7—Measured modulating response in db plotted as a function of frequency

A test which simulates busy conditions consists of loading all but the first and last voice channels with uniform noise at a level which produces peak frequency deviation. Comparing the levels obtained in the first and last channels to any loaded-channel level results in a measure of distortion at the receiver demodulated output which can be expressed in terms of an interference level in the channel with normal voice loading. For the exciter described, this level is 1 dba at the −9 db transmission level for a capacity of 36 4-kc voice channels. Therefore, the total interference level due to exciter noise and distortion is 4.6 dba at the −9-db transmission level.

The maximum channel capacity of the exciter is principally a function of the frequency response shown in Fig. 7. The measured curve indicates that the exciter is capable of handling at least 132 voice channels in addition to the order-wire facilities.

Reliability Considerations

Despite improvements in reliability and performance, tubes are still a primary cause of equipment failure. Since high operating temperature is a major cause of tube failure, any significant reduction in the ambient operating temperature of vacuum tubes appreciably improves equipment reliability. To accomplish this, forced air cooling is provided for all tubes in the exciter. The tubes in the uhf unit have mandatory cooling requirements and are cooled by a separate blower, interlocked for tube protection in case of blower failure. All remaining tubes are cooled by the rack blower and air duct.

Each unit has a plenum chamber that automatically couples to the air duct. Pressure in the plenum chamber then forces air through the special air-cooling tube sockets and out between the tube and tube shield, thereby eliminating the dead air pocket normally existing between tube and shield. In addition, corrugated shield and base liners conduct heat from the tube to the shield, and black shields increase heat radiation.

An indication of the effectiveness of the cooling system is the 145-deg. reduction in bulb hot spot when operating at maximum dissipation with the air socket, radiating shield and liner. To further increase tube reliability, all tubes are operated at less than 70 percent of rated cathode current.

Built-in test equipment facilitates maintenance and operational checks, and permits a complete tuneup on frequency by monitoring plate and grid current of all stages in the uhf unit, r-f power output, d-c power supplies and modulator signal levels. The units are hinged, permitting them to swing out for easy access to the rear of the chassis. An articulated hinge prevents interference with equipment mounted in an adjacent rack.

Front panel includes variable controls, meter and connections for optional devices (left) Sensing probes (right) include basic unmounted element (A), 10-gauss uncooled model (B), 100-gauss convection-cooled version (C) and 300-gauss conduction-cooled unit (D)

Magnetometer Makes

Developed for use in an electron cyclotron, instrument monitors magnetic field strength continuously with accuracy of 0.1 percent. Probe design varies with application, one type employing quadrupole construction for magnetic isolation and a heat sink for cooling. Lower field-strength models delete the heat sink while higher field-strength forms sacrifice the quadrupole configuration. Electronic system is closed-circuit servo loop, with internal r-f excitation to bring magnetic field to knee of B-H curve of probe

By **FERDINAND VOELKER** Radiation Laboratory, University of California, Berkeley, California

MANY MAGNETS are designed for a uniform field over as large an area of the pole pieces as possible. Measuring the magnetic field under these circumstances is relatively easy. Where the gap may be as small as 0.5 in. and where the field must agree both radially and circumferentially with mathematically determined values, as in an electron cyclotron, magnetic measurements can be tedious.

Continuous Measurement

The magnetometer described here is designed for continuous magnetic measurements in such a cyclotron and meets requirements of 0.1-percent accuracy in fields of 10 to 100 gauss, continuous monitoring of the field to follow automatic plotting against the probe position, horizontal-position accuracy of about 0.005 in. and quadrupole probe construction to minimize effects of nearby iron.

The instrument consists of the sensing probe to detect the magnetic field, and its associated electronic chassis. The probe is a small transformer comprising three windings with a high-permeability core, as shown in Fig. 1. The primary comprises two outer layers and four inner layers, while four intermediate layers serve as a secondary. The mean diameter of the inner layers is approximately $1/\sqrt{2}$ of the mean diameter of the two outer layers. Thus the area of the inner winding is about the same as that between the outer and inner windings.

When the two windings are connected so that current in them flows in opposite directions, the primary acts as a magnetic quadrupole, causing the field in the region around the probe to fall off much more rapidly than it would with a single coil. This helps isolate the

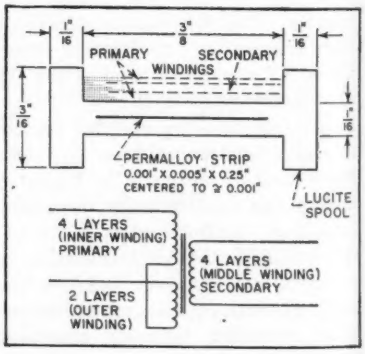
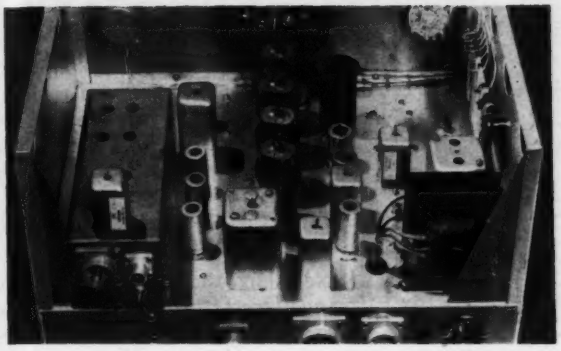
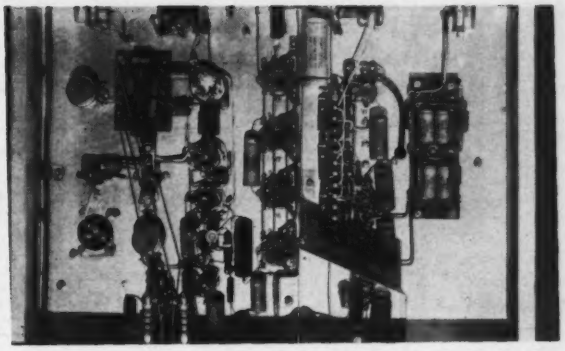


FIG. 1—Mechanical and electrical details of sensing probe construction. The primary acts as a magnetic quadrupole when current flows in opposite directions



Top chassis view shows standard component used in the construction of the magnetometer



Use of common chassis requires shielding between several elements to prevent interaction

Continuous Measurements

probe from nearby magnetic materials, but also reduces the total ampere-turns acting on the core to 0.33 of its value if the windings were connected series-aiding.

Operation

In operation there is a small r-f current and a relatively large amount of d-c flowing in the primary. Since the effective ampere turns of the primary determines the maximum range of the instrument, this figure should be as large as possible.

The relatively small size of the coil imposes an arbitrary limit of 300 ma, with the I^2R loss conducted to a heat sink surrounding the coil. At this current the plastic core approaches softening temperature and the maximum measurable field is about 100 gauss.

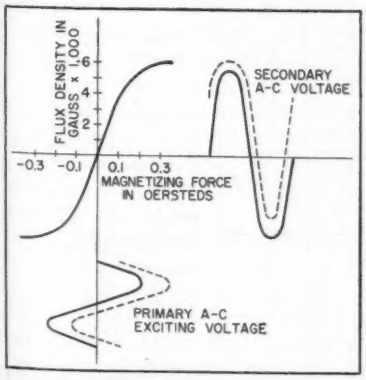


FIG. 2—Excitation level and magnetic characteristics of core cause secondary voltage to be rich in odd harmonics

One form of probe has fins for convection cooling of the heat sink. Another, designed for measurement of the earth's magnetic field, has a maximum rating of 10 gauss or 30 ma and no heat sink is necessary. Still another version of the probe sacrifices the quadrupole construction to obtain a 300-gauss maximum. This probe is used in a vacuum and has a conduction-cooled heat sink.

The magnetization curve of the core is approximately as shown in Fig. 2. The primary winding is excited with an r-f voltage just sufficient to bring the magnetic field to the knee of the curve. The voltage induced in the secondary is rich in harmonics, but because of the symmetry of the curve they are all odd if there is no d-c field. But a d-c field as small as 2 millioersteds generates appreciable amounts of even harmonics.

Probe Response

The even harmonics are used to servo d-c through the primary in a direction that minimizes even-harmonic production and cancels the external d-c field in the region around the core. The probe response is therefore quite linear, with d-c in the primary proportional to the external field. Because of the large length-to-cross-section ratio of the core, the probe responds to the component of the magnetic field that is parallel to the core.

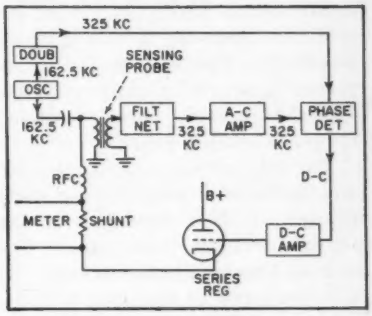


FIG. 3—Functions of magnetometer elements

A functional diagram of the magnetometer is shown in Fig. 3. The number of components in the feedback loop make it a difficult one to close. The filter network and a-c amplifier are designed to have a phase shift of less than 90 deg from 225 to 425 kc. Since there are large amounts of odd harmonics and only a feeble second harmonic at the secondary of the sensing probe, the problem is to amplify only the second harmonic without excessive phase shaft. Bridged-T filters are used, as shown in Fig. 4, to accomplish this.

The amplifier shown in Fig. 5 is designed to amplify the second-harmonic signal while rejecting higher harmonics and low-fre-

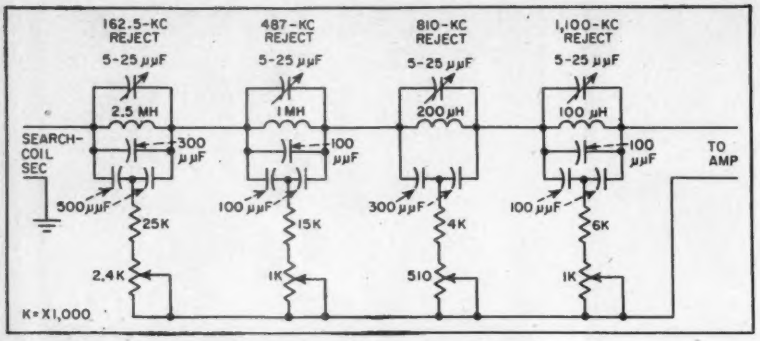


FIG. 4—Multisection bridged-T filter is used to reduce sensing probe output to second harmonic alone without encountering excessive phase shift

quency noise. This is accomplished by a circuit tuned to the second harmonic, with the Q restricted to about ten to avoid excessive phase shift.

The fourth stage is used as a phase detector as well as a d-c amplifier. Its plate voltage consists of a sinusoidal signal at twice the oscillator frequency with 300 v peak amplitude. This voltage can be adjusted in or out of phase with the second-harmonic signal coming from the sensing probe.

The tube acts as a shunt rectifier and develops a negative d-c plate voltage which is dependent on the second-harmonic grid signal. The cathode bias is adjusted so that −35 v is developed at the plate with no grid signal. With the grid signal in phase the tube conducts more heavily and the rectified plate voltage becomes less negative. Conversely, with an out-of-phase signal the plate voltage becomes more negative.

Regulator Tubes

The rectified plate voltage is applied to the grids of four 6L6 tubes in parallel, which serve as a series regulator to control bias current in the search coil. A bridged-T filter tuned to the second-harmonic is necessary at this point to attenuate the a-c signal applied to the amplifier plate. A shunt capacitor together with the source impedance of the rectifier serves both as filter and as the time constant on which the servo loop is closed. It provides a phase shift of 6 db/octave to 100 kc, under circumstances where the loop gain is less than unity.

The total range of voltage on the 6L6 grids can vary from 0 to 100 v, which allows them to control bias current from 300 down to a few ma. As these tubes approach cutoff their transconductance becomes less and less.

Maintaining Gain

Normally the loop gain of the magnetometer would also become lower, until at some current the accuracy would be less than required. To avoid this the cathodes are biased to a negative supply so that 10 ma of current is diverted around the search coil at all times. Thus with no current in the bias winding, corresponding to zero field, the tubes still have considerable gain.

Three shunts are provided to monitor the current through the bias winding. One is for a 1-percent front-panel meter and the other two have 0.1-percent accuracy for use with an external pen-type recorder.

The magnetometer has proved quite reliable and, when carefully adjusted, is capable of giving accuracies within a few millioersteds throughout its range. Even when it is not carefully adjusted, the instrument measures accurately to 0.1 percent on the 100-gauss range, which is satisfactory for many applications.

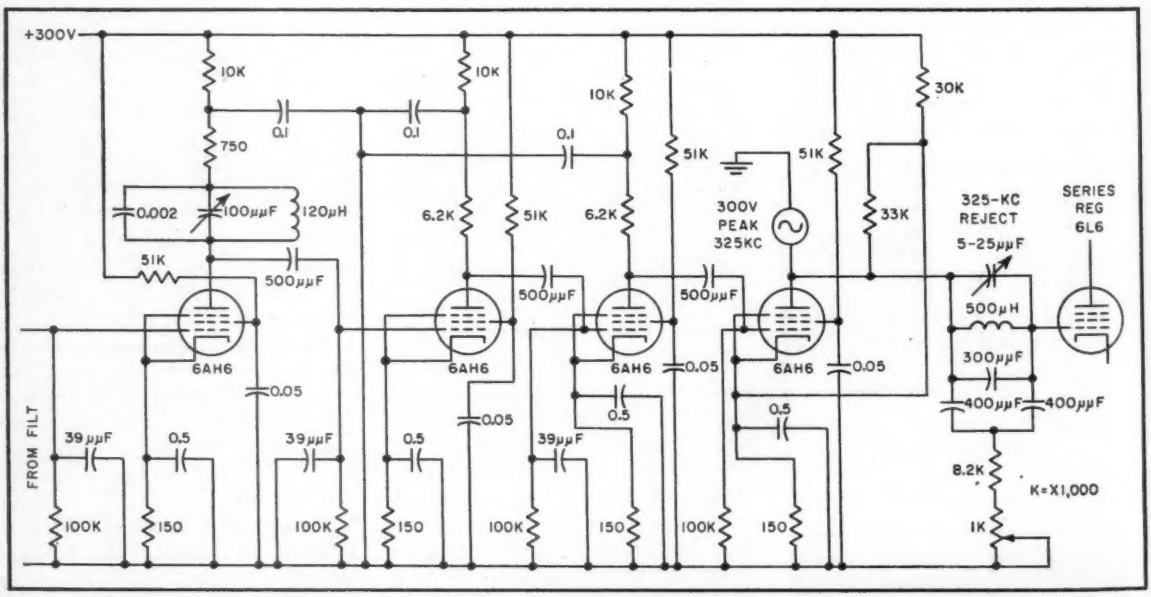


FIG. 5—Circuit details of the a-c amplifier, phase detector and d-c amplifier elements of the magnetometer system

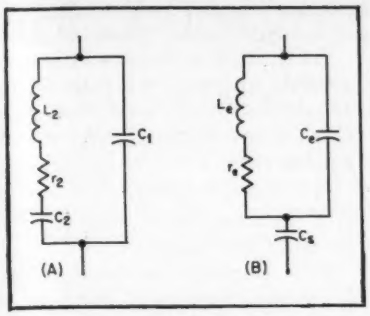


FIG. 1—Equivalent circuits for piezoelectric crystal. E-R version formulas for (A) to (B) are given in article

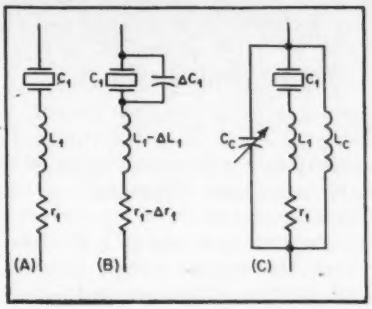


FIG. 2—Basic crystal circuit (A), lower impedance version (B) and its use with tuned circuit

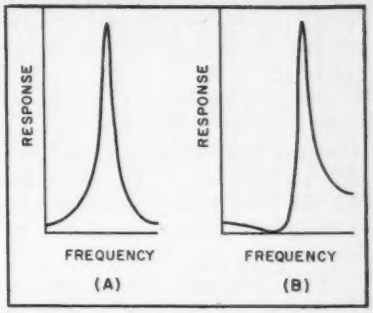


FIG. 3—Crystal circuit response when paralled by resistor (A) and with L_1 or C_1 misadjusted

Stable Crystal Filter Is Parallel Resonant

High-Q, unbalanced crystal circuit has properties similar to low L/C-ratio parallel-tuned circuit over appreciable frequency range. Ease of circuit design and adjustment makes it readily adaptable for use in f-m oscillators, signal generators, i-f amplifiers and variable-bandwidth filters

By **J. CARL SEDDON** Rocket Sonde Branch, Atmosphere and Astrophysics Division, U. S. Naval Research Laboratory, Washington, D. C.

ELECTRONIC Q-MULTIPLIER circuits for improving the Q of parallel-tuned circuits have been described in the literature[1, 2, 3] for frequencies of 0.5 mc or less. Cascading of such circuits is impractical because Q-multiplication does not improve the frequency stability. Crystal circuits, which have both Q and stability, have the disadvantages that they are usually balanced, are tedious to design and are not readily adapted to variable bandwidth.

The crystal circuit described here is stable, unbalanced and easy to design and adjust. It was devised to improve the selectivity of radio receivers used in radio propagation studies using rockets.

Signals approaching the millivolt level would sometimes be present within 2 or 3 kc of the weak signal received from the rocket. Although the permissible bandwidth of the system was only 0.5 kc, more than one stage of selectivity was required to eliminate such competition. In addition, as considerable testing was necessary before the rocket firing, it was desirable to have the bandwidth variable, as signal generators can drift out of a 0.5-kc band when operating near 10 mc.

The circuit was incorporated into the receiver's local oscillator where a stable frequency, which could be varied over a narrow range of frequencies, was desired.

Crystal Circuit Theory

Figure 1A shows the conventional equivalent electrical circuit for a piezoelectric crystal.

Figure 1B shows another equivalent circuit which makes the behavior somewhat easier to visualize. Although it is not rigorously correct to do so, L_2, C_2 and r_2 can be assumed to be constants in practical design problems. The conversion formulas for Fig. 1B are

$$C_e = C_1 + C_2 \cong C_1 \qquad (1a)$$

$$L_e = L_2\left(\frac{C_2}{C_1 + C_2}\right)^2 \cong L_2\left(\frac{C_2}{C_1}\right)^2 \qquad (1b)$$

$$C_e = \frac{C_1(C_1 + C_2)}{C_2} \cong \frac{C_1^2}{C_2} \qquad (1c)$$

$$r_e = \left(\frac{C_2}{C_1 + C_2}\right)^2 r_2 \cong \left(\frac{C_2}{C_1}\right)^2 r_2 \qquad (1d)$$

Fig. 1B can be converted into a parallel-resonant circuit at one frequency by adding a coil L_1 in series with the crystal, of such a magnitude that it will series resonate with C_1, the capacitance of the crystal in its holder and socket. This ca-

pacitance can be measured easily by using a Q meter or bridge at a frequency at which the crystal does not vibrate.

The parallel-resonant crystal circuit is shown in Fig. 2A. This circuit will be referred to hereafter as the crystal circuit. The impedance of the circuit may be reduced by adding an additional capacitor ΔC_1 as shown in Fig. 2B.

At a frequency f near the parallel-resonant frequency f_p the impedance is approximately

$$Z = r_1 + j4\pi f_p L_1 \delta + \frac{L_c/C_c}{r_c + j4\pi f_p L_c \delta} \quad (2)$$

where $\delta = f/f_p - 1$ is the percentage of frequency deviation from resonance and r_1 is the resistance of coil L_1.

For small values of δ, the first two terms of Eq. 2 are of small significance and the response is essentially that of a parallel-tuned circuit. For frequencies far from resonance, the response is that of a series-resonant circuit.

Minimum Z is obtained when the reactance is zero; this occurs at a value

$$\delta_m \cong \pm \tfrac{1}{2}\sqrt{C_2/C_1} \quad (3)$$

Circuit Response

There is a minimum resistance of r_1 at a frequency difference of $\delta_m f_p$ cycles each side of resonance. The response of the circuit follows the universal resonance curve closely until the impedance has decreased to a value comparable with r_1. This usually occurs at a value of not less than 90 percent of δ_m. For larger values of δ the impedance increases slowly.

Ratio C_2/C_1 is important as it is nearly equal to the square of the coefficient of electromechanical coupling. For a wire-mounted plated AT-cut crystal, the best ratio that can be obtained is not larger than 1/180.[4] Where the capacitance of the holder and socket must be included, the ratio runs about 1/230; thus $\delta_m = \pm 3.3$ percent as a maximum for AT-cut crystals, which compares favorably with values obtainable with magnetostriction resonators. The equivalent circuit is the same, except that inductors and capacitors are interchanged. For BT-cut crystals, δ_m is about ± 2 percent.

The basic circuit can be paralleled by a resistor R or a tuned L-C circuit, as shown in Fig. 2C, to give a lower resultant Q given by

$$Q_R = Q_2 \frac{R}{(R + R_p)} \quad (4)$$

where Q_2 is the crystal Q and R_p is the maximum resistance of the crystal circuit.

Paralleling a tuned L-C circuit with the crystal circuit improves the Q of the L-C circuit and reduces its temperature coefficient materially because the crystal's C_c is large and has an effective temperature coefficient of the order of only a few parts per million per deg C. The combination will have a low reactance at all frequencies not near f_p except for two symmetrical responses at $f_p \pm \delta_r f_p$.

The deviation of these side responses can be found from the relation

$$\delta_r = \pm\sqrt{\frac{L_c}{4L_1} + \delta_m^2}$$

$$= \pm\sqrt{\frac{C_1}{4C_c} + \delta_m^2} \quad (5)$$

where L_c and C_c are the values used in the tuned circuit. These side responses are not particularly serious in general, as they can usually be removed by a following amplifier stage having only the usual L-C tuned circuit, tuned to f_p. Another method is to use different values for L_c in successive stages.

The resultant bandwidth BW can be found by appropriate substitutions into Eq. 4 to obtain

$$BW = 1\Big/\left[2\pi RC_1\left(\frac{C_1}{C_2}\right)\left(1 - \frac{Q_R}{Q_2}\right)\right] \quad (6)$$

As Q_2 is 10^5 or more, it is usually possible to ignore the ratio Q_R/Q_2. If a crystal is to be used whose ratio C_1/C_2 is not known, it may be calculated from

$$C_1/C_2 = f_p/[2(f_p - f_s)] \quad (7)$$

if f_p and the series resonant frequency f_s are measured.

If a narrower bandwidth, BW', is desired, compute C_2 from Eq. 7 and then from Eq. 6 obtain the total capacitance C_1' required. Add enough capacitance in parallel with the crystal to give this required capacitance. If the resultant frequency f'_p is not quite equal to the final center frequency desired, a parallel reactive component may be added across the crystal circuit to tune it to the correct frequency.

Table I shows the comparison of the measured values of Q_R compared with those calculated from Eq. 4 using various resistors, R, in parallel with a crystal circuit similar to that of Fig. 2A. The crystal used was an air-gap type transmitting crystal with a C_1/C_2 ratio of 2,350 ($\delta_m = \pm 1$ percent). The crystal circuit parameters were $f_p = 848.4$ kc, $L_1 = 1.86$ mh, $L_c = 0.79$ μh, $Q_2 = 129{,}000$, $L_2 = 4.4$ h, $C_c = 44{,}600$ $\mu\mu$f, $R_p = 544{,}000$ ohms, $C_1 = 19$ $\mu\mu$f, $r_c = 0.00005$ ohm.

Figure 3A shows the response of the above crystal circuit paralleled by a resistor; Fig. 3B shows the effect of a misadjustment of either L_1 or C_1. At the expense of a poorer

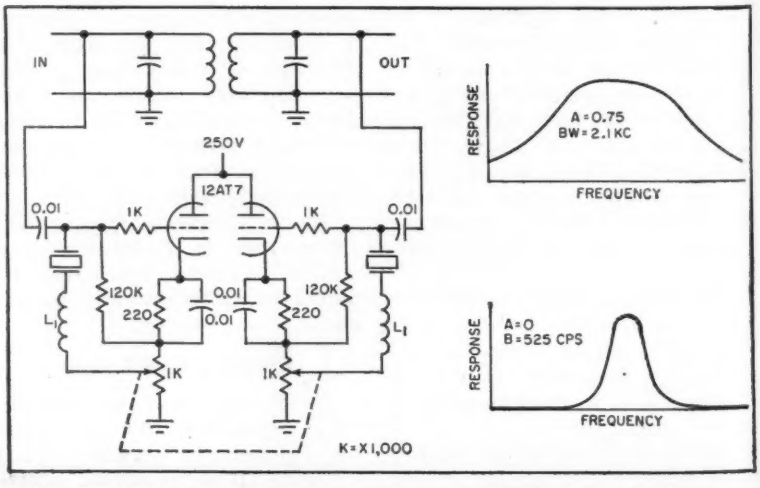


FIG. 4—Variable bandwidth circuit and responses at 848.54-kc center frequency

response on one side, the response can be made quite steep on the other side.

Use in I-F Amplifiers

The crystal circuit may be applied to i-f amplifiers already built, but which are not sufficiently selective, by connecting it in parallel with one or more of the L-C circuits in the amplifier. At least one L-C circuit should not be so paralleled, to remove the effects of the side responses.

It is possible to retain the center-frequency gain within a few percent if the plate circuit impedances are not too large. Standard 456-kc i-f amplifiers have high plate impedances, so that it may be necessary to tap down on the inductances. However, to obtain the fullest benefit from this crystal circuit, the i-f amplifier should operate at a higher frequency to obtain good image rejection and to make the needed component values easier to obtain. Five mc has been found to be a convenient frequency at which to operate.

If a flat-topped response characteristic is desired, stagger-tuning may be employed, but the overall gain is reduced. If the receiver has double-tuned transformers, one crystal circuit may be placed across the primary and one across the secondary.

If the impedance of the transformer at resonance is much smaller than that of the crystal circuit at resonance, the critical coupling coefficient and the center-frequency gain is not appreciably altered; the bandwidth is reduced with the shape of the response curve the same as before.

This method was tried on two amplifier stages with critically coupled transformers in an 845-kc amplifier with a bandwidth of 12 kc. The shape of the response curve was the same, but the new bandwidth was 0.5 kc. The maximum gain was reduced a few percent.

Similar bandwidth reductions were obtained with a 5.1-mc amplifier where the bandwidth was reduced from 50 kc to 5 kc.

Bandwidth may be decreased in steps by incorporating a switch that increases the capacitance in parallel with each crystal and at the same time reduces L_1 correspondingly. The coefficient of coupling of the transformers need not be altered. This method will cause a slight change in the center frequency.

Figure 4 shows an arrangement for securing a continuously variable bandwidth over a 4 to 1 range with no change in the shape of the response curve. It has the desirable features that the gain in the pass band is essentially unaltered and the center frequency of the pass band is constant.

The crystal circuit was placed in the input circuit of a cathode follower, so that the input impedance was $Z_i = Z/(1 - A)$ where Z is the crystal circuit impedance and A is the cathode follower gain. The input to the cathode follower was connected across the primary of an ordinary double-tuned transformer. Another similar circuit was placed across the secondary. Gains were kept approximately equal by the ganged potentiometers. The responses shown were obtained for $A = 0$ and $A = 0.75$ at a center frequency of 848.4 kc.

Use in Oscillators

The crystal circuit was connected across one tank circuit of a regenerative amplifier type of oscillator to provide a stable oscillator that could be easily set to a new frequency by a variable capacitor.

Figure 5 shows the frequency variation obtained with a 100-$\mu\mu$f capacitor using a 3.87-mc crystal. The dotted lines show the variation obtained if the capacitor across the crystal (part of C_1) is either too large or too small, thus introducing asymmetry in the crystal circuit response. The total variation in C_1 was 10 $\mu\mu$f. The voltage amplitude for the symmetrical case is also shown plotted in percent of maximum amplitude. An oscillator was constructed for field use at 7.75 mc which covered a frequency deviation range of 0.3 percent.

Paralleling the crystal circuit with a capacitor results in r_1 reducing the Q and consequently the maximum impedance of the circuit. If X_{C_a} is the reactance of the added parallel capacitor, the maximum impedance of the circuit is in general reduced by the same amount as though a resistor of approximately $X_{C_a}^2/r_1$ ohms were added in parallel with the circuit. Thus there is a limit to how far the circuit can be detuned without serious loss of Q. Also, the temperature coefficient increases as the frequency is tuned away from f_p.

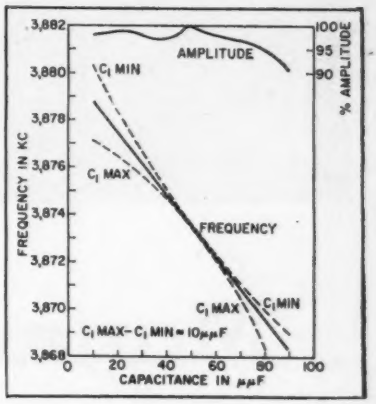


FIG. 5—Performance of variable-frequency crystal oscillator

The high selectivity obtained with this circuit is useful in spectrum analyzers. The circuit was also used in a standard type of frequency discriminator circuit.[5]

The author acknowledges helpful discussions with J. E. Jackson. G. H. Spaid supplied almost all of the data on the applications.

Table I—Measured and Calculated Q for Various Values of Parallel Resistors

R (Ohms)	Q (Meas.)	Q (Cal.)	Percent (Diff.)
75,000	15,400	15,700	2
27,200	6,050	6,140	1.5
14,500	3,265	3,360	3
7,300	1,740	1,710	1.7

References

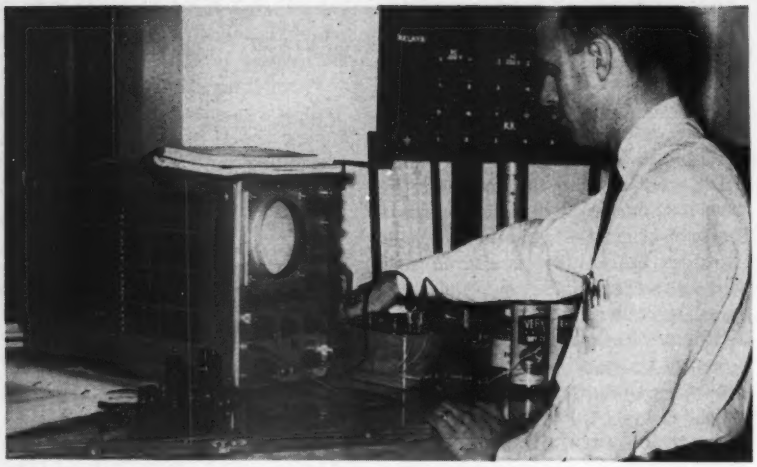
(1) H. E. Harris, Simplified Q-Multiplier, ELECTRONICS, p 130, May 1951.

(2) J. W. Muehlner, Transfer Properties of Single and Coupled Circuits with and without Feedback, *Proc IRE*, p 945, Aug. 1951.

(3) O. G. Villard, Jr. and W. L. Rorden, Flexible Selectivity for Communications Receivers, ELECTRONICS, p 138, Apr. 1952.

(4) D. F. Ciccolella and L. J. Labrie, High Frequency Crystal Units for Use in Selective Networks and Their Proposed Application in Filters Suitable for Mobile Radio Channel Selection, *Trans IRE*, PGVC-3, p 118, June 1953.

(5) R. Adler, A Gated-Beam Discriminator, ELECTRONICS, p 82, Feb. 1950.



Waveforms of magnetic inverter are checked on oscilloscope and effects of bias variations determined

Magnetic Inverter Uses

Collector and emitter-coil windings of the on transistor of multivibrator are differentially connected across input voltage so that turns in drive winding partially determine frequency of oscillation. Common-base resistor extends operating range by limiting base-to-emitter drive without waveform deterioration. Reliable operation is obtained without current bias. Alternate electron-tube circuit description is also given along with characteristics

By C. H. R. CAMPLING Associate Professor, Department of Electrical Engineering, Queen's University, Kingston, Canada

TRANSISTOR-MAGNETIC INVERTERS are finding increasing applications in signal and power conversion. For signal conversion, they give results similar to those given by electromechanical vibrator converters and for power conversion they produce high voltage from a low-voltage d-c power source. Frequency as well as output amplitude is directly proportional to the input voltage.

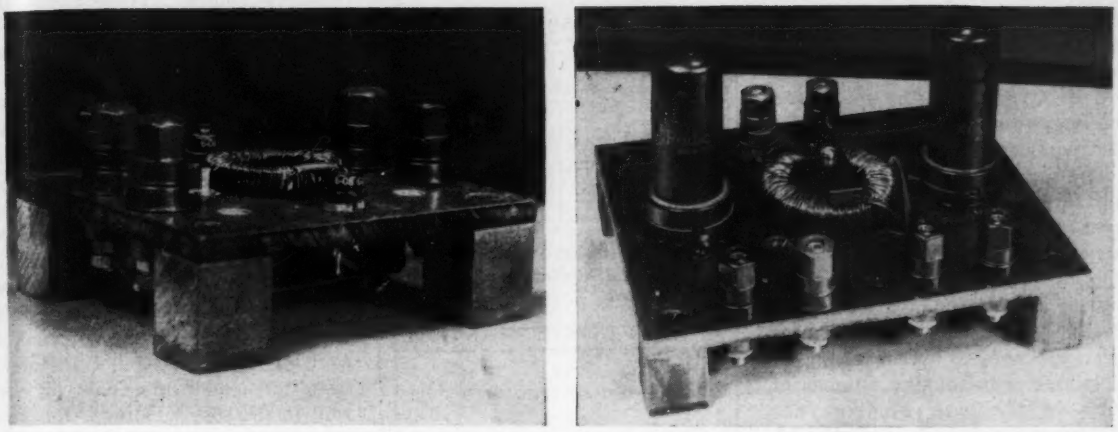
For power conversion, the magnetic inverter can substitute for the dynamotor type of rotating machine used in aircraft electrical systems and in military electronic equipment. Chief advantage of the magnetic inverter is that it is entirely a static device in which the switching action is accomplished by transistors or electron tubes.

This article describes a differential multivibrator inverter circuit.[1] Its basic operation is similar to the more common type of inverter.

Basic Theory

An improved version of the non-differential multivibrator described by Royer[2] is shown in Fig. 1. The circuit is analogous to its free-running capacitor-coupled counterpart. In the latter, the time interval during which either switching element conducts or is cut off depends upon capacitor charge time. In the magnetic-coupled multivibrator the corresponding interval is determined by the time required for the flux in a magnetic core to change its level. The core flux change extends from positive to negative saturation or vice versa, although in other circuit modifications one flux level can be preset and controlled.[3]

In Fig. 1 consider transistor Q_1 to be conducting. Since the drop across the emitter to collector terminals is small, nearly the entire supply voltage V_{bb} is applied across the collector winding of N_2 turns. Polarity of other induced voltages is indicated by winding dots. The voltage developed by the base windings N_1 keeps transistor Q_1 conducting. The current-bias source (E_b and 68,000-ohm combination) limits the base-drive current and prevents overheating. When transistor Q_1 is conducting the voltage



Component layout indicates physical relationship and relative size for transistorized inverter (left) and tube inverter (right)

Tubes or Transistors

developed across the collector windings N_2 tends to cause transistor Q_2 to conduct. In fact, the collector-to-emitter voltage for transistor Q_2 is twice the input voltage V_{in}. But the voltage appearing across base windings N_1 keeps Q_2 cut off.

During this quasisteady state, the core flux is changing over the steep unsaturated portion of its magnetization characteristic and the core and windings can momentarily be regarded as an ideal transformer. The winding voltages are steady because the voltage sustaining the flux change in the core is V_{in}.

Core Saturation

Transistor Q_1 conducts until the core saturates. Time of saturation is a function of N_2 and V_{in} in accordance with Faraday's law that $d\phi/dt = V_{in}/N_2$. When the core saturates, the core and windings are no longer regarded as an ideal transformer. The winding voltages collapse and the bias source forces conduction of one transistor. Furthermore, the energy stored in the core can only be released by a decrease in the flux from its saturation level. Therefore, transistor Q_2 conducts. The transistors exchange roles rapidly and during the next half cycle transistor Q_1 is cutoff. Evidently, both the frequency and the amplitude of the output square wave depend directly upon V_{in}. The frequency is given by $f = V_{in}/4N_2\phi_m$ where ϕ_m is the saturation flux. The linear dependence of f upon V_{in} makes the circuit applicable for telemetering. For loads of appreciable magnitude, there is efficient conversion of d-c source power to square-wave load power. Consequently, inverters can substitute for rotating electromechanical converters.

Clipping Diodes

Diodes D_1 and D_2 in Fig. 1 clip leading-edge spikes of the square wave when a transistor switches from on to off. The output waveforms for the circuit with and without the diodes are shown in Fig. 2A and 2B. The spikes should not be eliminated by shorting the bias source as E_B ensures reliable circuit oscillations and limits the on transistor base current to a minimum heating value.

For the saturated on transistor, the product of base current and base-to-emitter voltage can exceed the product of collector current and collector-to-emitter voltage.[4]

The spikes in Fig. 2B occur because the bias source cannot function properly as a current source

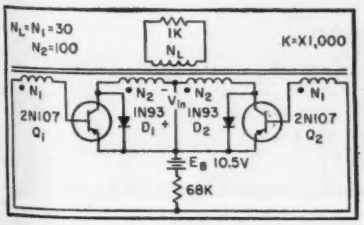


FIG. 1—Inverter is analogous to free-running cathode-coupled multivibrator

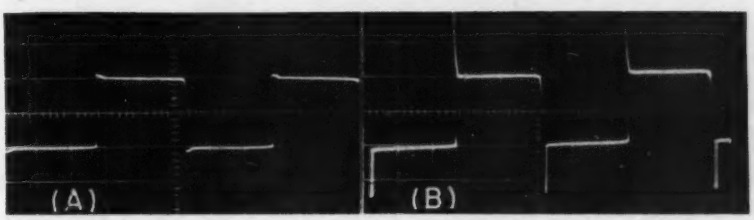


FIG. 2—Diodes of modified inverter clip spikes of output (A) while original inverter spikes appear (B). Scales are 1 v per amplitude division and 0.5 millisec per time division

unless one transistor is fully conducting. During the transition interval, the resistance of the bias path is momentarily too high. The use of the diodes is the most effective way to eliminate transients at all frequencies.

The multivibrator of Fig. 1 has one serious disadvantage. To increase the frequency V_{in} must be increased, and as V_{in} increases all winding voltages including the base voltage of the on transistor increase. Excessive base drive causes the transistors to overheat.

Neither reducing the number of turns in the base windings nor adding resistance in series with these windings can effectively avert overheating. If the base-winding turns are reduced, the circuit is likely to cease oscillation at low input voltages. On the other hand, the addition of series resistance in the base circuit causes the flat portions of the output waveform to be replaced by decay transients.

Differential Multivibrator

Most of the disadvantages inherent in the simple transistor-magnetic inverter are eliminated in the differential circuit of Fig. 3. This circuit oscillates reliably without the use of current bias. Since any spikes appearing in the output waveform are less than 1/2 μsec in duration, the clipping diodes are omitted. If the spikes are objectionable, they can be eliminated by connecting small capacitors between collector and emitter of each transistor. Furthermore, the common-base resistor R_B limits the base-to-emitter drive without impairing the circuit waveforms.

With the circuit in oscillation, one transistor is cut off and the other is fully conducting. If transistor Q_1 is conducting, the voltage V_{in} appears across N_2 turns in series with N_1 turns, neglecting the small collector-to-emitter drop. The series differential connection of collector and emitter windings provides an emitter-to-base drive of the correct polarity to sustain conduction. Similarly, the transformer voltage across the N_1 emitter windings of Q_2 is of the correct polarity to keep transistor Q_2 cut off despite its high collector voltage. Because of conduction in transistor Q_1, the rate of change of flux in the core is $d\phi/dt = V_{in}/(N_2 - N_1)$. Core-flux excursion from negative to positive saturation occurs more quickly than in the inverter of Fig. 1. When the excursion is complete, the winding voltages collapse. Transistor Q_1 is then cut off, transistor Q_2 conducts for the next half-cycle and the process is repeated.

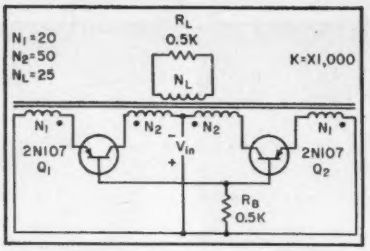


FIG. 3—Magnetic inverter with differentially connected windings oscillates without current bias

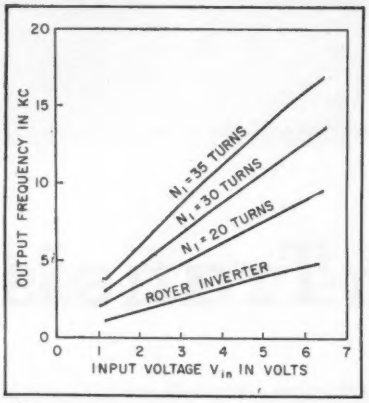


FIG. 4—Frequency characteristics of modified circuit (lowest curve) has components of Fig. 3. Remaining curves for differential inverter with N_1 as parameter

While the turns in the emitter drive windings influence the oscillation frequency, it is possible to prevent transistor overheating caused by excessive drive. Even high turns ratio values, compared with those required for the circuit of Fig. 1, are offset by the insertion of resistor R_B which limits the base current of the on transistor. The limiting action does not interfere with the load components of current in the core windings. Resistor R_B does not carry these currents. Furthermore, R_B does not cause deterioration of the clean rectangular output waveform. Finally, its limiting action is effective over a wide range of the input voltage V_{in}.

Oscillation Frequency

The circuit is called a differential multivibrator or inverter because of the differential action of the collector and emitter windings. Since the rate of change of core flux is affected by the differential connection, the frequency of oscillation is too. The frequency is given by $f = V_{in}/[4(N_2 - N_1)\phi_m]$. The differential circuit produces, for the same set of components and the same input voltage, a higher output frequency than does the circuit arrangement of Fig. 1.

Comparative Characteristics

The family of characteristics shown in Fig. 4 indicates the effect of varying the number of turns N_1 in the feedback or emitter windings of the circuit in Fig. 3. The lowest curve is obtained with the same components indicated in the circuit of Fig. 3, but with the circuit arrangement of Fig. 1. For this set of components, in which the com-

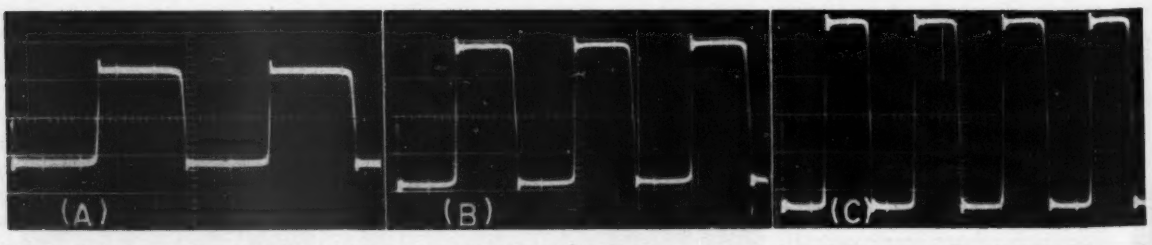


FIG. 5—Output waveform of differential inverter of Fig. 3 with 0.01 μf capacitor connected between collector and emitter of each transistor to clip pip. Input voltage V_{in} = 3 v (A), 4.5 v (B) and 6 v (C). Each waveform amplitude is 2 v per large division and time scale is 50 sec per large division

mon base resistor R_B is optimized by trial, little further advantage occurs from the increase in slope obtained with an increase in N_1 as ultimately the waveform deteriorates. However, the insertion of resistors of the same magnitude as R_B in series with the bases of the transistors in a circuit like that shown in Fig. 1 completely alters the output waveform at all frequencies. Thus, the differential circuit permits the use of this simple self-adjusting protective feature which operates effectively over a wide range of voltage, frequency and the parameter N_1.

Thermal instability at the 6-v level on the lowest curve in Fig. 4 emphasizes the importance of the base resistor in extending the operating range. The upper curves, obtained using the differential circuit with the limiting resistor, represent stable operation at the 6-v level without noticeable heating of the transistors.

Output waveforms for the differential circuit of Fig. 3 are shown in Fig. 5. The emitter windings consisted of 20 turns each. The three waveforms correspond to V_{in} equal to 3, 4.5 and 6 v respectively.

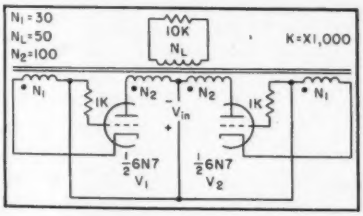


FIG. 6—Differential electron tube inverter gives best results when separate grid resistors are used

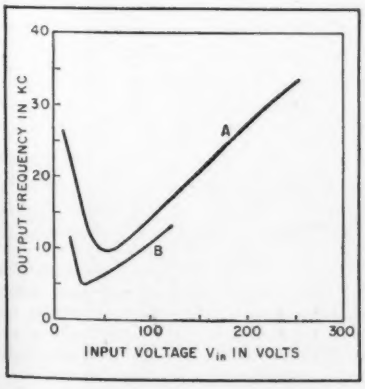


FIG. 7—Frequency characteristics for electron-tube inverter using separate half-tubes *A* and a single common cathode without grid resistors *B*

Table 1—Voltages of Differential and Nondifferential Circuit

Voltage	Nondifferential Inverter of Fig. 1	Differential Inverter of Fig. 3
Peak a-c voltage across collector windings N_2	V_{in}	$V_{in}\frac{N_2}{N_2-N_1}$
Peak a-c voltage across drive windings N_1	$V_{in}\frac{N_1}{N_2}$	$V_{in}\frac{N_1}{N_2-N_1}$
Peak collector-to-emitter voltage for off transistor	$2\,V_{in}$	$2\,V_{in}$
Peak a-c load voltage	$V_{in}\frac{N_L}{N_2}$	$V_{in}\frac{N_L}{N_2-N_1}$

A comparison of several of the voltage levels in the differential circuit are given in Table I for both the circuit of Fig. 1 and the differential circuit of Fig. 3. While the differential connection increases the individual winding voltages, it does not increase the peak collector-to-emitter voltage for the off transistor.

Transistor-Tube Comparison

Electron tubes can also be used as the switching elements although they are less efficient than transistors in this application. The drop across an on tube and the relatively large current drawn by its grid are the main reason for lower efficiency. Nevertheless, tubes at present may be better in some applications because of availability with a suitable combination of voltage rating, current rating and capacity for switching at high speed.

Electron-Tube Circuit

A differential inverter using electron tubes as the switching elements is shown in Fig. 6. Best results are obtained with separate grid resistors. The extension of the permissible upper limit for V_{in} is noteworthy because the large grid currents associated with the nondifferential circuit limit its usefulness. Two separate tubes must be used because the common cathode of the double triode 6N7 precludes the use of its two halves as the two switching elements in the differential circuit. At low values of the input voltage, in the same order of magnitude as the voltage drop across the on tube, the output frequency rises as the voltage is lowered. This behavior is associated with a flux excursion in the magnetic core over a minor but symmetrical hysteresis loop. The switching process occurs before the flux in the core reaches the saturation level. The low-voltage region is of limited utility for ordinary purposes because the output waveform deteriorates from its clean rectangular shape, and the frequency becomes dependent upon the load.

With transistors, the drop across the on switching element is small and as the input voltage decreases to tiny values the circuit ceases oscillation before a region of increasing frequency is reached.

Typical frequency characteristics for the circuit of Fig. 6 are shown in Fig. 7. Frequency characteristic *B* is that of a nondifferential circuit using the same components without protective resistors. In each case the maximum frequency shown is the highest obtained without rapid deterioration of the circuit operation due to overheating. Overheating is caused, particularly in the nondifferential circuit, by excessive grid current. The characteristics emphasize the extended range of operation which can be obtained with the differential circuit.

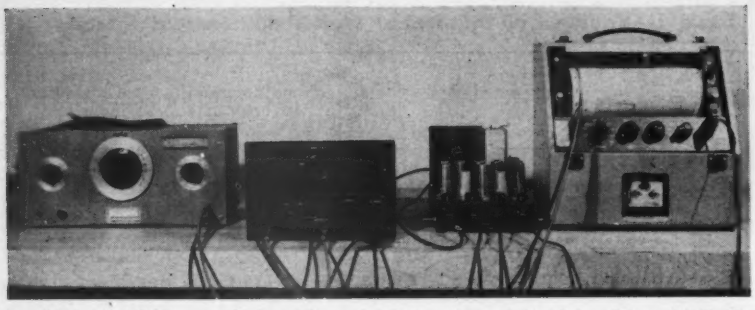
References

(1) C. H. R. Campling, Differential Magnetic Multivibrators, *AIEE Conf*, Paper No. 57-769.

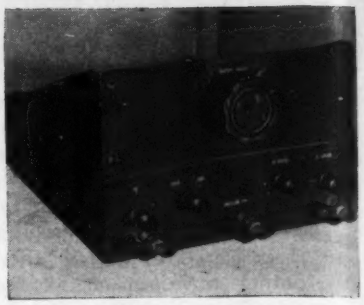
(2) G. H. Royer, A Switching Transistor D-C to A-C Converter Having An Output Frequency Proportional to the D-C Input Voltage, *AIEE Trans*, part I, p 322, July 1955.

(3) R. L. VanAllen, A Variable Frequency Magnetic-Coupled Multivibrator, *AIEE Trans*, part I, 356, July 1955.

(4) R. L. Bright, Junction Transistors Used as Switches, *AIEE Trans*, part I, p 111, Mar. 1955.



Amplitude distribution analyzer with associated equipment for determining distribution of various noise waveforms obtained from missile radar systems



Front view of analyzer. Knob is used to control bias placed on input wave

Simple Plotter Analyzes

TO EVALUATE NOISE and vibration, signal data on both power against frequency and amplitude-distribution density against amplitude must be available. Several versions of spectrum analyzers can provide the power-frequency characteristics automatically. However, the amplitude-distribution density has not been easily obtained.

The method most widely used to determine the amplitude-distribution function involves a slow and costly data reduction process. Recorded on either paper or film, the wave amplitude is measured and tabulated at regular intervals of time and the results are then reduced numerically to provide a histogram on the amplitude-distribution density of the signal.

Automatic Method

The amplitude-distribution analyzer, described in this article and developed for analyzing radar noise at the Naval Air Missile Test Center, provides a simple and rapid method for obtaining the amplitude-distribution density of noise signals in the audio frequency range. It produces an automatic plot of the amplitude-distribution density with an accuracy of about 5 percent with coarse resolution. Distribution density can be plotted almost as fast as the analyzer is operated.

Signals to be analyzed have a frequency range from 0 cps (d-c) to 1,000 cps. The present system performs well from 1 cps to 10,000 cps, but with redesign the lower limit can be extended down to essentially d-c. The plotter is similar to one developed by the Naval Research Laboratory[1] but is much less complex.

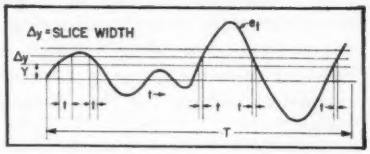


FIG. 1—System is based on the principle that the amplitude distribution density plot is the ratio of Σ_t to T

Theory of Operation

A typical signal to be analyzed is shown in Fig. 1. The system is based on the following principle. As a function of time the amplitude-distribution density of an electrical signal is the relative probability that the signal amplitude lies within an interval of amplitude Δy, which is between the level Y and $Y + \Delta y$. The amplitude-distribution density plot is the ratio of Σt, the time the waveform spends between Y and $Y + \Delta y$, to T, the total time of measurement at level Y. This relationship can be expressed:

$$\int_Y^{Y+\Delta y} P(e_t)\,de_t = \frac{\Sigma_t}{T} \qquad (1)$$

where $P(e_t)$ is the probability distribution of the waveform, e_t; t is the time that waveform e_t lies between Y and $Y + \Delta y$; and T is the total time that the interval Δy is positioned at Y. This amplitude-distribution analyzer presents an output voltage E that is proportional to $\Sigma t/T$. Therefore, from Eq. 1

$$E = K\Sigma_t/T = K\int_Y^{Y+\Delta y} P(e_t)\,de_t$$

Circuit Description

Figure 2 contains the block diagram of the analyzer. The schematic is shown in Fig. 3. The waveform to be analyzed e_t is amplitude gated or sliced, that is, a small amplitude interval or slice

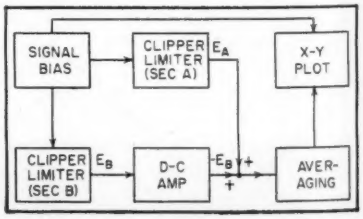


FIG. 2—Block diagram of amplitude-distribution analyzer. Analyzer effectively inspects only small amplitude interval of input wave. Input wave to be analyzed is biased and then amplitude gated by two clipper limiters, one samples positive slice and the other samples negative. Output is average voltage E of gated portion

Device plots amplitude-distribution density required for complete analysis of noise and vibration signals within 1 to 10,000 cps with an accuracy of 5 percent of maximum amplitude. Circuit illustrates principle that amplitude-distribution density of an electrical signal is a function of time wave spends between two adjacent amplitude levels

By DANIEL J. ZOLL U. S. Naval Air Missile Test Center, Point Mugu, California

Radar Noise Rapidly

of the signal is allowed to pass through the system for inspection. The voltage output from the slice is an average voltage E.

The input signal level is made to vary in d-c potential by adding a bias voltage to the input. As the bias is varied, different amplitude levels of the input waveform are sampled by the slice. If E is plotted as a function of the bias voltage, an approximation to the probability distribution of e_i, $[P(e_i)]$, will be plotted. If the slice width approaches zero, or infinite resolution, the plot approaches $P(e_i)$.

Basically, the device consists of two clipper limiters or slicers that maintain a narrow interval between the clipping and limiting levels. The two clipper limiters, sections A and B, are used to amplitude gate the signal and form E.

Section A samples the d-c biased input signal, e_i + bias, between zero and + ½ slice width. The output of section A is shown in Fig. 4. Because of a relatively narrow slice, the output of section A is essentially a negative square wave with amplitude equal to −½ slice width. The average value of this waveform is E_A.

Section B inspects the biased input signal between zero and −½ slice width. The output of section B is inverted and biased to +½ a slice width by a d-c amplifier so that essentially a positive square wave is produced. The average value of this output waveform is E_B.

The output of sections A and B is summed through the output of the d-c amplifier. The average of the combined waveform E is now plotted by an X-Y recorder to display the amplitude-distribution of the waveform. Thus, a plot of E against d-c bias is a first approximation to the amplitude-distribution function of the input waveform.

For audio signals, the X-Y will average E, but for subaudio signals the filter R_5, C_4 must be used.

The requirements for the d-c amplifier used in this analyzer are low d-c drift rate and a frequency response to 1,000 cps.

Operation

Operating controls for the distribution analyzer are two slice level potentiometers, the bias scan potentiometer, an X-axis scale factor control, and an on-off switch. The first step in operation of the analyzer is to balance the d-c amplifier and to adjust the two slice level potentiometers until both diode sections are producing the same magnitude. Proper scales are then selected on a two-axis plotting board, Y-Y recorder, and finally

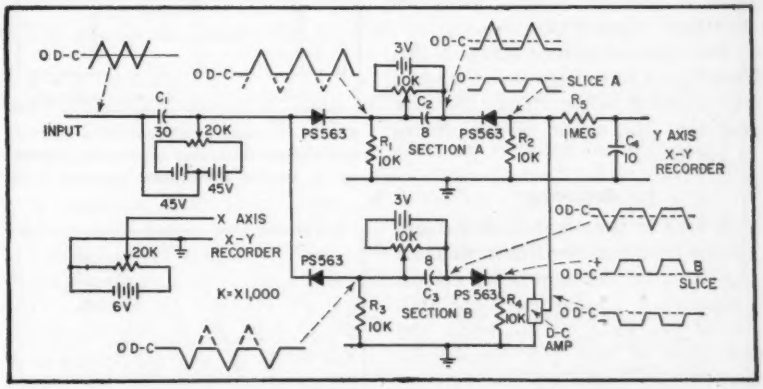


FIG. 3—Schematic of amplitude-distribution analyzer. Clipper limiter *A* samples d-c biased input signal between zero and positive half of slice width. Clipper limiter *B* samples d-c biased input signal between zero and negative half of slice width. Output of *B* is inverted and biased to produce positive square wave by a d-c amplifier. Recorder plots average wave *E* of combined *A* and *B* output

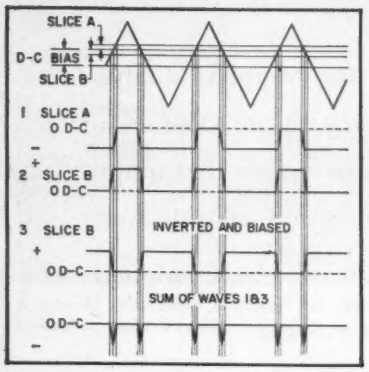


FIG. 4—Circuit waveforms of the analyzer for an input triangular wave

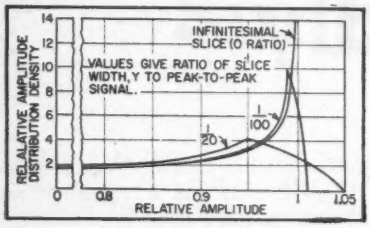


FIG. 5—Theoretical amplitude-distribution of a sine wave for different ratios of slice width to peak-to-peak sine-wave amplitude as used in technique described

the bias scan potentiometer is used to slowly sweep the amplitude of the input signal producing the distribution density versus amplitude on the X-Y recorder.

Input signals for the present model must be less than 90 v peak-to-peak, the full swing of the d-c bias, so that a full amplitude sweep may be obtained. The peak-to-peak value of the signal should be as near as possible to 90 v to obtain maximum resolution.

The approximations made in this description have been that the wave has constant slopes inside the slice and that the action of the diodes is perfect.

Accuracy

Errors in the present system are caused by resolution limitations of the circuits and errors of circuit components. Resolution is the ability of the analyzer to define the structure of the true amplitude-distribution of the input waveform. Resolution is directly related to slice width, which must approach zero if E is to be exactly proportional to $P\ (e_i)$. Experimentally, the slice width is several percent of the peak-to-peak input signal amplitude because of equipment limitations. Component errors are caused primarily by the silicon diodes and the d-c inverting amplifier. Silicon-diode error increases at high frequencies. At frequencies below 1,000 cps the error is quite small.

Drift Error

Direct-coupled amplifier error is caused by amplifier drift. This drift causes an output error that is inversely proportional to the amplitude of the output signal. Therefore, the output signal must be made as large as possible to minimize this error.

The analyzer output signal E is proportional in magnitude to the slice width and should be larger than the expected drift of the d-c amplifier. Thus, the amplifier drift error must be balanced against resolution error.

Slice width to peak-to-peak signal amplitude ratio is defined as the resolution ratio. Resolution ratio is limited to 1:20 because of amplifier drift. However, if a stabilized d-c amplifier is used, the drift error is negligible and a resolution ratio of 1:100 is possible. In this case, the silicon diodes are the primary cause of system error.

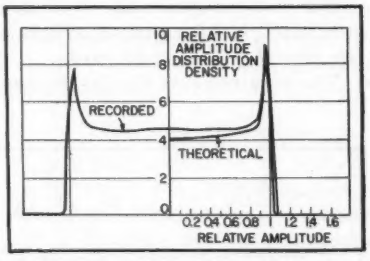


FIG. 6—Theoretical and recorded distribution density for a sine wave. Slice width Δy to peak-to-peak input ratio at 1/20

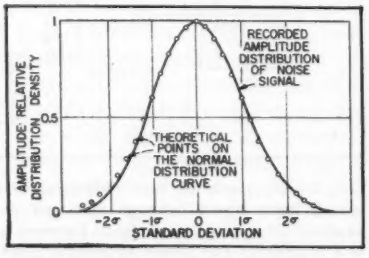

AMPLITUDE RELATIVE DISTRIBUTION DENSITY
RECORDED AMPLITUDE DISTRIBUTION OF NOISE SIGNAL
THEORETICAL POINTS ON THE NORMAL DISTRIBUTION CURVE
STANDARD DEVIATION

FIG. 7—Recorded amplitude distribution of the output of a random noise generator

Error in the equipment is defined as the percentage deviation of the analyzed distribution from the theoretical distribution with respect to the maximum value of the plotted distribution. This is similar to percent of full scale used for many meters. The present equipment will plot the distribution of noise inputs with an error of 5 percent or less.

If a stabilized amplifier and a resolution ratio of 1:100 are used, the analyzer error is reduced to less than 2 per cent for frequencies below 1,000 cps.

Sine Wave Inputs

For sine wave inputs, maximum error will exceed 5 percent because of the large error caused by resolution limitations. Figure 5 is a plot of a part of the amplitude-distribution of a sine wave. The effect of different resolution ratios is illustrated.

Figures 6 and 7 are plots of distribution densities for a sine wave and for random noise. Theoretical distribution for a sine wave is infinitely discontinuous at maximum signal amplitude. The analyzer cannot reproduce this part of the distribution accurately as is shown in Fig. 5.

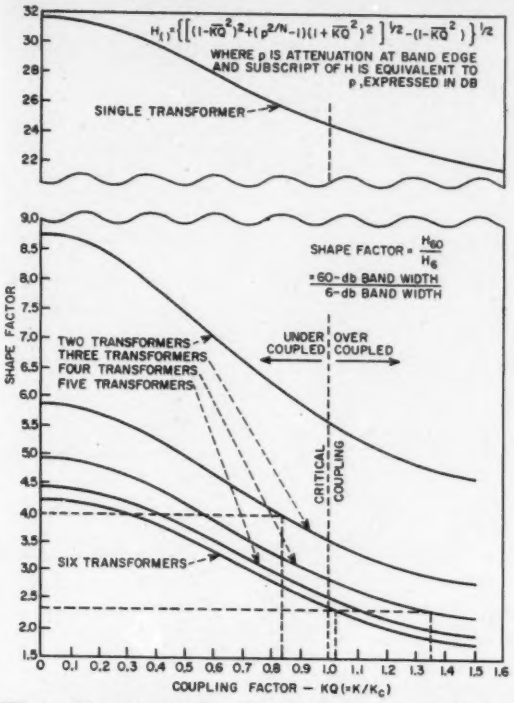
Figure 7 shows the plotted and theoretical distribution density of a normal random noise signal. The analyzer results compare quite favorably. Good results can be expected for any distribution that is continuous.

Conclusions

From the results obtained from the use of this analyzer, it is evident that this device will produce an amplitude-distribution analysis with an error of not more than 5 percent of the maximum amplitude of the distribution for any noise signal between the frequencies, 1 cps to 10,000 cps. With improved design and components outlined in this article, the analyzer may have better resolution, 1:100 vs 1:20, an error of less than 2 percent, and a frequency range extending to zero.

Reference

(1) An Amplitude-Distribution Analyzer, Naval Research Laboratory, Washington, D. C. NRL Report 3890, Dec. 29, 1951 (Unclassified).



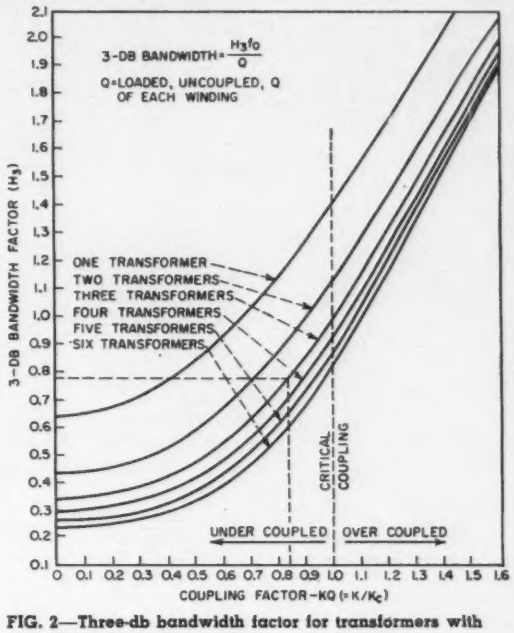


FIG. 2—Three-db bandwidth factor for transformers with two identical coupled circuits

FIG. 1—Shape factors for single and cascaded double-tuned transformers vs coupling factor. Curves are solutions of the equation shown which also applies to Fig. 2 and 3

H-F Amplifier Design

Any narrow-band h-f tuned amplifier can be designed from the accompanying curves and a minimum of additional information. The step-by-step method is directed to the bread-and-butter circuits of communications system design—narrow-band i-f amplifiers, r-f stages, and audio filter circuits. It relies only on provision of a set of design specifications

By **ALBERT E. HAYES, JR.*** Mechanical Div., Engineering Research and Development, General Mills, Inc., Minneapolis, Minn.

TYPICAL DESIGN specifications for a narrow-band h-f tuned amplifier give the amount of gain required from a completed unit, the bandwidth at either the 3-db or 6-db points, and the 60-db bandwidth. The problem is to determine the number of amplifier stages and transformers required; the transistor (or tube) types to be used; and the specifications for the i-f or r-f transformers to be used.

A simplifying assumption is made that $Q_{pri} = Q_{sec}$ in each case. In narrow-band amplifiers it is seldom necessary to use transformers having unequal primary and secondary Q.

A quantity bandwidth factor (H) is introduced to normalize the design charts about any specified center frequency. This factor is defined as follows: $H_3 =$ 3-db bandwidth $\times Q/f_o$ and $H_6 =$ 6-db bandwidth $\times Q/f_o$, where H_3 and H_6 are the 3- and 6-db bandwidth factors, respectively; f_o is the center frequency of the pass band; and Q is the loaded uncoupled Q of each transformer winding ($Q_{pri} = Q_{sec}$).

The term coupling factor is applied to the quantity KQ, where K is the coupling coefficient and Q is as defined previously. This expression is identical with K/K_c, K_c is critical coupling.

Use of the Tools

Assume that the following performance characteristics are specified for an amplifier: shape factor, overall gain, 3-db band-

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(continued on page 168)

Amplifier Design (continued from page 165)

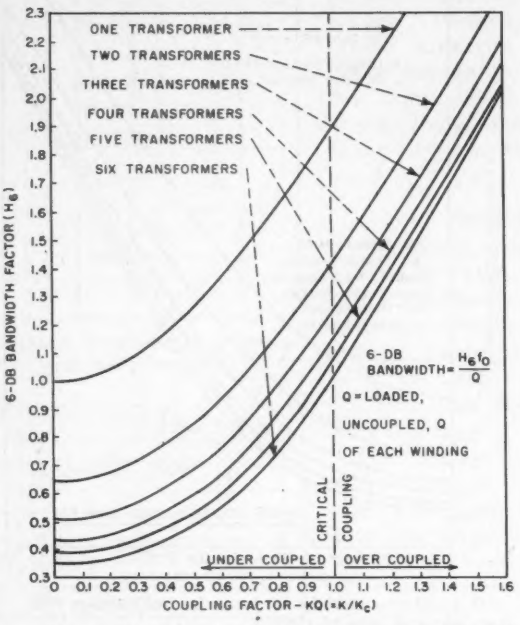


FIG. 3—Six-db bandwidth factor for transformers with two identical coupled circuits

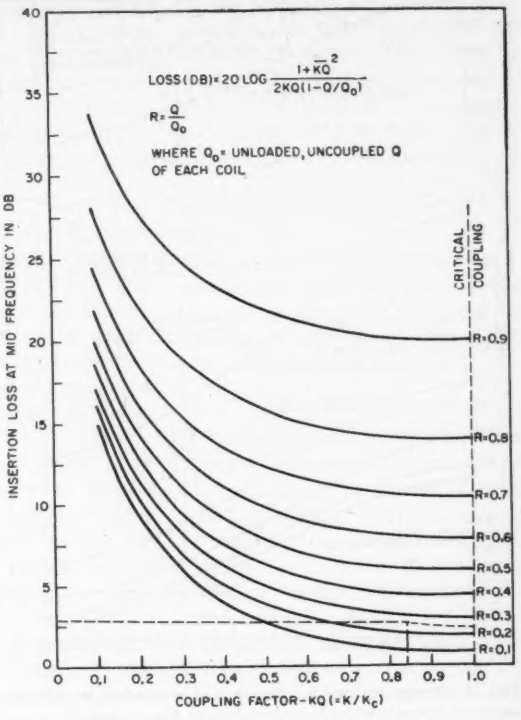


FIG. 4—Insertion loss of a single transformer at its midfrequency for varying values of the Q/Q_0 ratio

width, and center frequency. The design procedure is as follows:

(1) Enter Fig. 1 with the specified shape factor. Determine the minimum number of stages required and their coupling factor.

(2) Verify that suitable transistors are available to provide the specified gain with the number of stages determined in step 1. If not, select a higher number of stages, and lower KQ.

(3) Determine the 3-db bandwidth factor, H_6, by entering Fig. 2 with the number of stages and the coupling factor determined in steps 1 and 2.

(4) Compute the required loaded, uncoupled Q of the transformer windings from $Q = H_3 \times f_o/$ overall amplifier bandwidth. (Note: If the 6-db bandwidth rather than the 3-db bandwidth is specified, Fig. 3 should be used in place of Fig. 2, and H_6 should be used in place of H_3 in step 4.)

(5) Determine the insertion loss of each transformer from Fig. 4. Use a value of R based on the value of Q found in step 4 and the expected value of unloaded, uncoupled Q attainable within the limitations of the problem.

(6) Determine total gain of the amplifier by subtracting the total insertion loss of the several transformers from the gain attainable with the transistors used. This step constitutes a check on the estimate made in step 2. If the total computed gain is less than that called for in the specifications, solutions of step 2 are avilable for a recomputation.

Example

A typical set of design specifications are: gain, 60 db min; frequency (f_o), 455 kc; 3-db bandwidth (BW), 8 kc; and shape factor (S), 4.

(1) Enter Fig. 1 with the specification that $S = 4.0$. The curves show that a minimum of three i-f transformers are needed. Three transformers with their coupling adjusted to $KQ = 0.84$ will provide the exact shape factor specified.

(2) From Fig. 2, follow the $KQ = 0.84$ line to its intersection with the three-transformers line. The 3-db bandwidth factor (H_3) can then be read as 0.78.

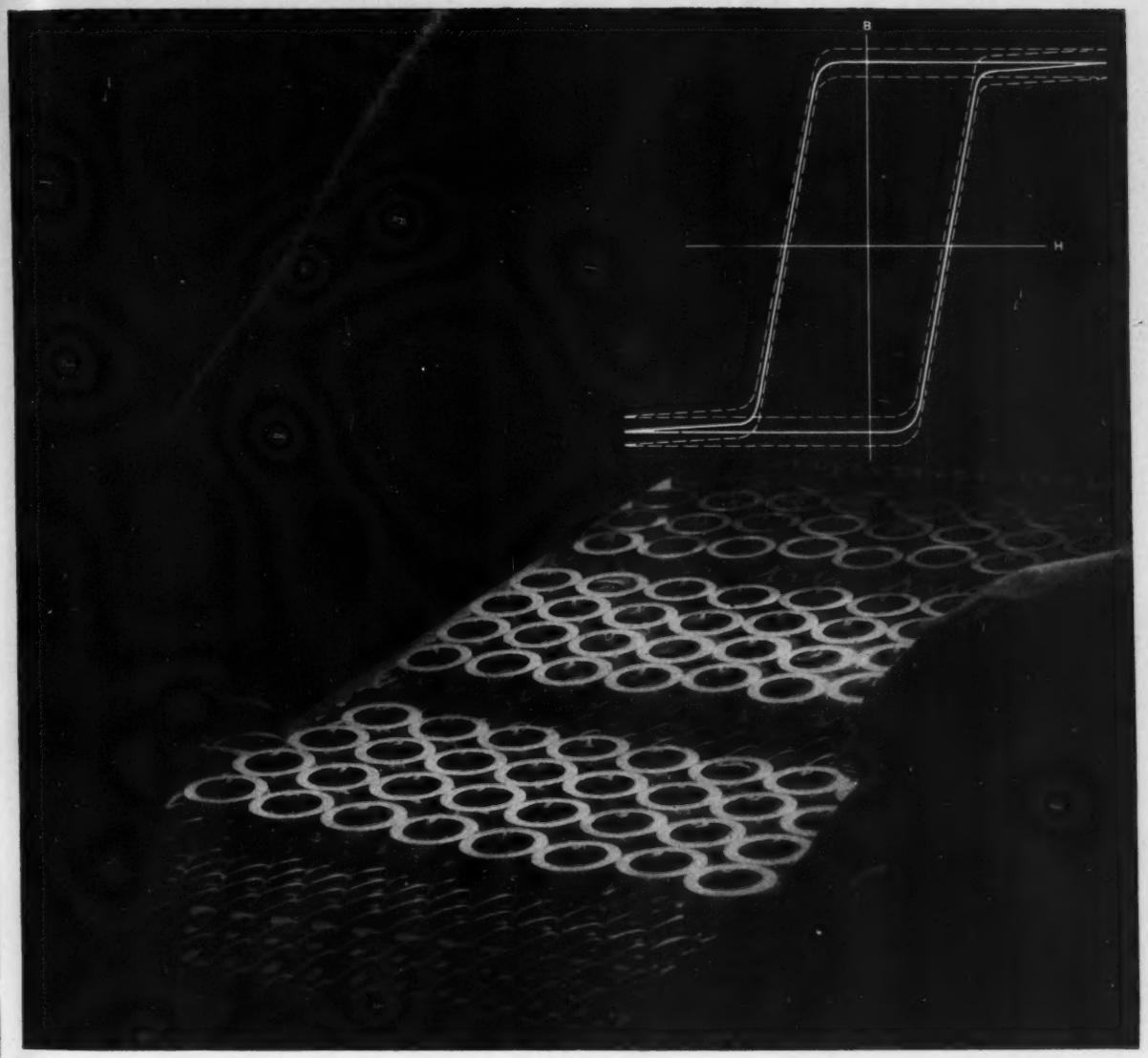
Since $BW = H_3 f_o/Q$, the required loaded, uncoupled Q of each transformer winding may be computed:

$$Q = H_{3o}/BW = 0.78 \times 455/8 = 44$$

Thus far, a requirment for three i-f stages incorporating three transformers, each having primary and secondary loaded Q of 44, with coupling factor adjusted to 0.84, has been found.

To predict insertion loss of each transformer, estimate the ratio of loaded to unloaded Q of the transformer windings. Previous experience shows that an unloaded Q of 175 is easily attainable at 455 kc with proper core and winding material. This magnitude gives a ratio of loaded to unloaded Q of about 0.25. Enter Fig. 4 with $R = 0.25$ and $KQ = 0.84$. Estimate insertion loss per transformer at 2.8 db for a total insertion loss (three

(continued on page 168)



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*Paper No. 58-71, Winter General Meeting, AIEE, February, 1958. Flux Reset Test is one of two tests proposed for standardization.

CIRCLE 132 READERS SERVICE CARD

Amplifier Designing (continued from page 166)

Table I—Max KQ for Max Permissible Double-Humping

Permissible peak-to-valley ratio (db)	Number of transformers					
	1	2	3	4	5	6
1	1.6	1.4	1.3	1.27	1.25	1.2
2	2	1.6	1.45	1.4	1.35	1.3
3	2.3	1.8	1.6	1.5	1.45	1.4

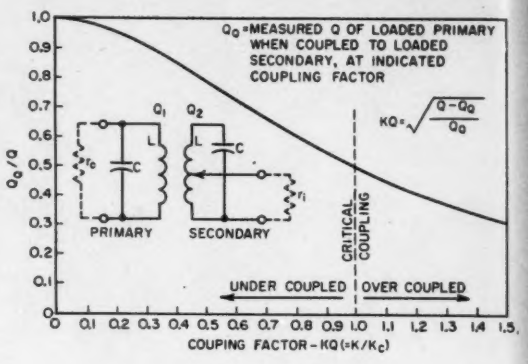

FIG. 5—Curve used for setting of coupling factor with a Q-meter as well as circuit of typical coupling transformer

transformers) of 3 × 2.8 or 8.4 db. To attain specified net gain of 60 db from the amplifier, 60 + 8.4 or 68.4 db of gain must be provided by the three transistors used. Fortunately, many transistors are available with sufficient gain to do the job.

The minimum number of stages may depend either on overall gain requirements, a maximum shape factor specification, or both. If, in the previous example, a shape factor of 2.4 was called for instead of 4, Fig. 1 reveals that four transformers at $KQ = 1.35$, five transformers at $KQ = 1.1$, or six transformers at $KQ = 1.02$ could meet the requirements.

Slight overcoupling may often save the complication and expense of an additional stage. Table I shows how far overcoupling may be carried without exceeding a specified maximum peak-to-valley ratio.

Transformer Design

Double-tuned transformers may now be specified if the output impedance of each driving stage and the input impedance of each driven stage are known. The transformer supplier may not be able to deviate from classical winding-machine settings. In this event, the following procedure, using previously computed data, will produce a proper transformer.

The untapped primary and tapped secondary arrangement shown in Fig. 5 is generally satisfactory for a coupling transformer. Primary and secondary coil inductance may be computed as follows:

$$L = \frac{r_o (Q_u/Q - 1)}{2f_o Q_u} \qquad (1)$$

where r_o is output resistance of driving stage; f_o is midband frequency; Q is loaded, uncoupled Q from step 4; and Q_u is unloaded, uncoupled Q of each winding. Trial windings will be necessary to determine the value of Q_u.

Capacitance C (Fig. 5) should be selected to resonate with L at the desired center frequency. Reactive components of the transistor input and output impedances my be taken care of by providing trimming controls on L, C, or both. Alternatively, reactance may be allowed for by modification of C.

Position of the secondary tap may be computed as follows:

$$N_T/N = (r_i/r_o)^{1/2} \qquad (2)$$

where N_T is the number of turns between tap and cold end of the secondary, N is the number of turns in each full winding, and r_i is the input resistance of driven stage.

With the aid of Fig. 5, coupling between the windings may be set on a Q meter to the desired value of KQ. First, terminate the windings with resistors to simulate the expected r_o and r_i. Then, adjust the coupling until the measured value of primary Q drops to the value (Q_0/Q) specified on the ordinate for the desired coupling factor.

As an example, design a transformer using Raytheon 2N112 transistors and meet the following requirements and conditions: r_i, 600 ohms; r_o, 25,000 ohms; $KQ = 0.84$; f_o, 455 kc; Q, 44; and Q_u, 175.

Compute inductance with Eq. 1

$$L = \frac{25 \times 10^3 (175/44 - 1)}{2 \times 455 \times 10^3 \times 175} = 150 \text{ } \mu\text{Hy}$$

From a reactance/frequency table, C is 810 $\mu\mu$f.

Position of the secondary tap may be computed with Eq. 2.

$$N_T/N = (600/25{,}000)^{1/2} = 0.155$$

or the secondary tap should be about 15 percent above the cold end of the secondary coil.

The coupling is adjusted to the required $KQ = 0.84$ (Fig. 5) as follows: (1) Connect a 25,000-ohm resistor across the primary terminals. (2) Connect a 600-ohm resistor between the secondary tap and the cold end of the secondary. (3) Connect the primary to a Q meter and resonate both primary and secondary with the slightest possible coupling. (4) Read primary Q. (5) Increase coupling until the measured Q drops to 58 percent of the value measured in step 4. The coupling factor is now at the required value of 0.84.

Since the 2N112 transistor has a published gain capability of better than 30 db per stage, 60 db in three stages is easily attainable.

Thanks are due B. D. Ramsey for the basis for Figs. 1 to 3.

A bird in hand...

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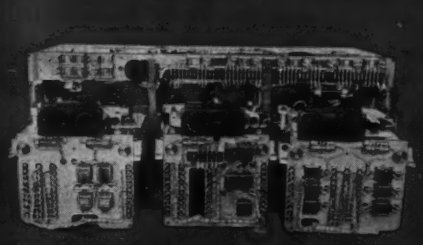

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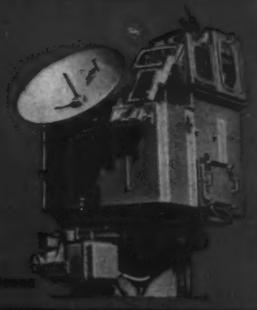

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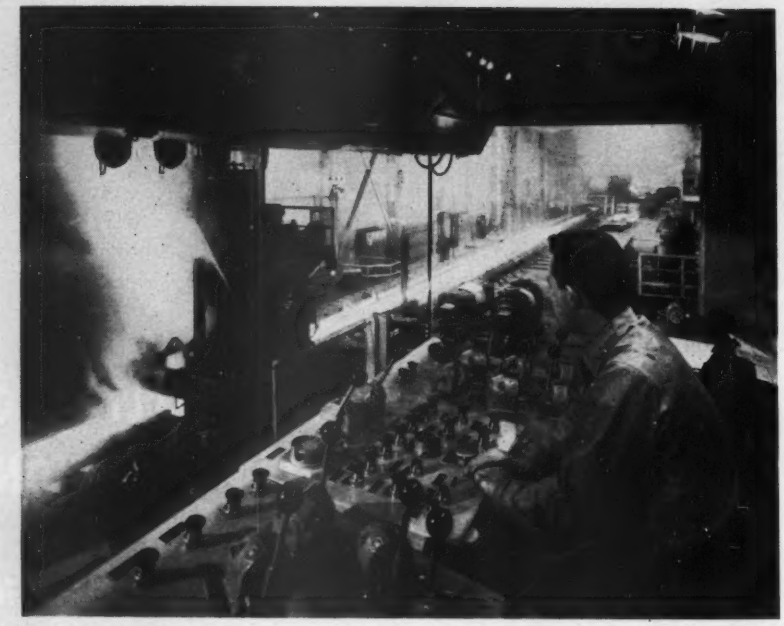

Digital and analog techniques are combined to control the operation of reverse roughing mill in new steel plant

CARD-PROGRAMMED system called Prodac will direct the operation of a 6,000-horsepower universal reversing roughing mill. The system was designed by Westinghouse for the new $36-million Aliquippa Works of the Jones and Laughlin Steel Corp.

With the system, the mill operator can press a single button to initiate the complete rolling sequence for a given slab. Information in punched-card form governs the setting of edger opening, edger speed, mill opening and mill speed.

When a stack of cards is inserted in an IBM card reader, the mill operator can begin to roll a sequence of schedules. To roll the first schedule, the operator presses a schedule advance button that causes the first punched card to be read by the card reader and its information to be stored.

A pass advance button causes information applying to the first pass to be used to set the separation and speeds of horizontal and vertical rolls. The slab then enters the edger and the mill.

When the slab has passed beyond a slowdown hot-metal detector, the mill decelerates to limit slab travel after it clears the rolls. When the slab has passed beyond the rolls, the load detector initiates a signal that stops the mill.

Simultaneously, information for the next pass is used to reset the edger and main roll separations and to establish speeds and direction of rotation for the next pass. The mill is then automatically accelerated, and the slab reenters the mill. Similar operations are repeated for each pass.

If several slabs are to be processed identically, the operator needs only to press the pass advance button and fully automatic operation results. If the second schedule is to be different, pressing the schedule advance button will cause information from the second card in the reader to be extracted. The new schedule will be executed automatically when the pass advance button is pressed.

To illustrate the signal sequence incorporated in Prodac, the subsystem for automatically controlling separation between upper and lower rolls will be described. Information applying to screwdown is transferred from punched card into storage by the IBM card reader. An analog signal representing actual roll separation is transmitted from the mill to an analog-to-digital converter for conversion into digital form.

When the operator presses the pass advance button to initiate rolling operations, digital reference information for the desired roll separation is extracted from storage and supplied to a digital difference detector. At the same time, the signal corresponding to actual roll separation is passed to the digital difference detector. The detector performs a subtraction that yields a resultant signal representing the difference between the actual and desired roll separation.

This signal applied through the digital-to-analog converter yields an analog signal for input to a magnetic amplifier. When output of the magnetic amplifier is supplied to a rotating regulator, an adjustable voltage drive adjusts the screws until roll separation is equal to that originally specified by the punched card.

Similar processes are used to control mill speed, edger speed and edger opening.

Neon Triode Gives Low-Speed Gate

By RONALD L. IVES
Palo Alto, Calif.

GATING CIRCUITS a generation ago usually employed electromagnetic relays, which were seldom useful at speeds above 1,000 operations per second. They were most dependable at the lower operating speeds.

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SC-32-1	0-32	0-1	0.01	0.1	19″	3½″	13″
SC-32-1.5	0-32	0-1.5	0.01	0.1	19″	3½″	13″
2SC-32-1.5	0-32	0-1.5	0.01	0.1	19″	7″	13″
DUAL OUTPUT	0-32	0-1.5	0.01	0.1			
SC-32-2.5	0-32	0-2.5	0.01	0.1	19″	3½″	13″
SC-32-5	0-32	0-5	0.005	0.05	19″	5¼″	13″
SC-32-10	0-32	0-10	0.001	0.01	19″	8¾″	13″
SC-32-15	0-32	0-15	0.001	0.01	19″	10½″	13″
2SC-100-0.2	0-100	0-0.2	0.1	1.0	19″	5¼″	13″
DUAL OUTPUT	0-100	0-0.2	0.1	1.0			
SC-150-1	0-150	0-1	0.05	0.5	19″	5¼″	13″
SC-300-1	0-300	0-1	0.1	1.0	19″	8¾″	13″

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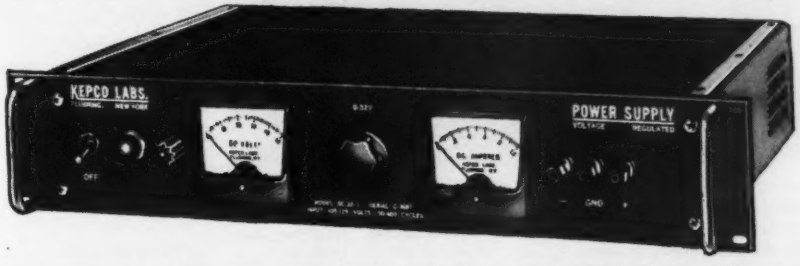

Model
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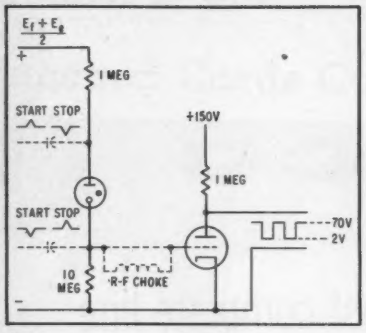

FIG. 1—Gating circuit may use 6AV6, ½12AX7 or other triode types to produce low repetition rate pulses

gratifyingly dependable at all speeds below the few million operations per second. However, component requirements (particularly for capacitors) become inordinate at very slow operating speeds. The ratio of standby power to controlled power also becomes quite high at these slower speeds.

Experiments with neon tubes and triodes, to replace the dual triodes used in most multivibrator circuits, indicate that a number of slow-speed gating problems can be solved by such circuits. These circuits provide a great saving in standby power.

Two specific circuits will be described with operating constants. A number of rather obvious alternate and derivative circuits are possible, and most of those tested work satisfactorily.

Upper limit of operating frequency of these circuits is in the vicinity of 5,000 operations per second, because of the slow deionization time of commercial neon tubes. Dependability of operation is enhanced if the neon tubes are constantly illuminated at almost any level above zero. Several spontaneous operations per month may be expected in exposed installations (probably caused by cosmic rays). However, the number of these operations is reduced to a very low figure (but probably not zero per year) by enclosure in a metal cabinet.

Off-On Gate

The circuit of an off-on gate is shown in Fig. 1. The supply voltage is set midway between the firing voltage (E_f) of the neon tube and its extinction voltage (E_e). The neon tube does not conduct unless triggered by a momentary increase in voltage. Once conducting, it will continue until the supply voltage is momentarily lowered below the extinction voltage.

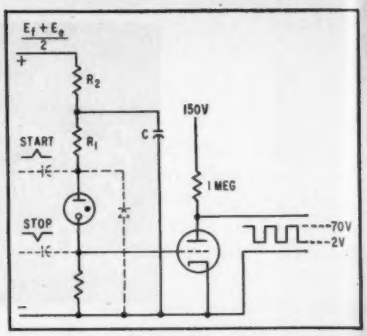

FIG. 2—If R_2 is much greater than R_1 and the reciprocal of time on is much less than prf, time on = 2.303 $R_1C \log_{10} (E_f + E_e)/2E_e$, while dead time = 2.303 $R_2C \log_{10} (E_f + E_e)/2E_e$

The neon tube is coupled to the triode by means of the triode grid resistor. The high value of this resistor biases the triode to low conduction. When the neon tube is conducting, the grid and cathode of the triode act as a diode, having negligible resistance. This action effectively short-circuits the triode grid resistor, so that the triode grid is very close to cathode potential when the neon tube is conducting. The triode therefore draws heavy plate current.

Triggering of this gate may be through a small capacitor in the anode circuit of the neon tube. With this arrangement, a small positive pulse momentarily increases the anode voltage of the neon tube, causing it to fire. This discharge, once started, continues as long as adequate supply voltage is present. A negative pulse applied through the same trigger input will momentarily lower the anode voltage of the neon tube below extinction level, and conduction will cease.

A similar triggering action can be made to take place through the cathode circuit of the neon tube. Here a negative pulse is required to start conduction. A positive shut-off pulse applied to the cathode of the neon tube will stop conduction. The triggering pulses are kept out of the triode grid-cathode circuit by means of a small r-f choke, indicated in Fig. 1.

Amplitude of the start pulse must always exceed the difference between the supply voltage and the firing voltage (E_f) of the neon tube. A small correction for contact po-

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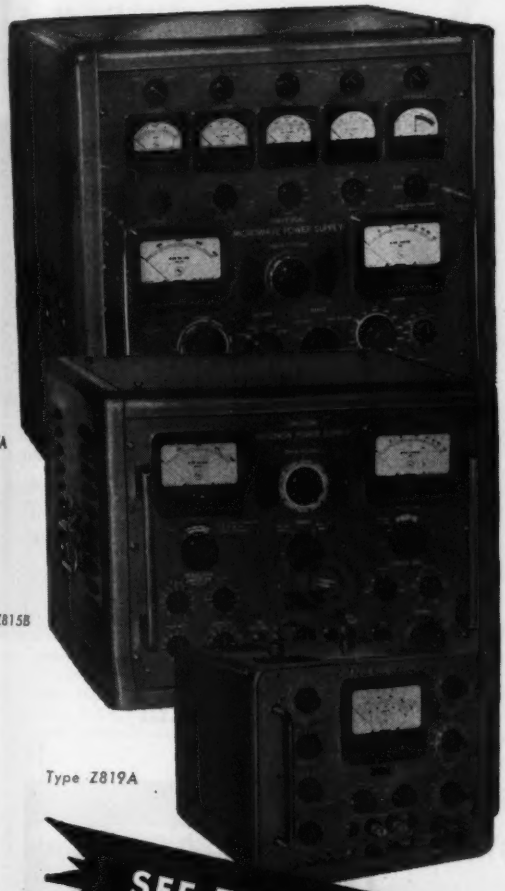

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Anode: 0-600 V, 60 ma max.
G-1: 0-300 V, 5 ma max.
G-2 or Reflector: 0 to ± 1200, 1 ma max.
G-3: 0 to ± 750, 1 ma max.
G-4: 0 to ± 500, 1 ma max.
Regulation: 0.03%
Ripple: 3 MV max.
Heater: 0 to 15 V D.C., Regulated
Internal G-1 or G-2 Modulation: Square Wave, Pulse, Sawtooth, Sine Wave

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Reflector: 0-1000 V
Control Grid: −300 to 0 to +150 V, 5 ma max.
Regulation: 0.03%
Ripple: 3 MV max.
Internal Reflector Modulation: Square Wave, Pulse, Sawtooth, Sine Wave

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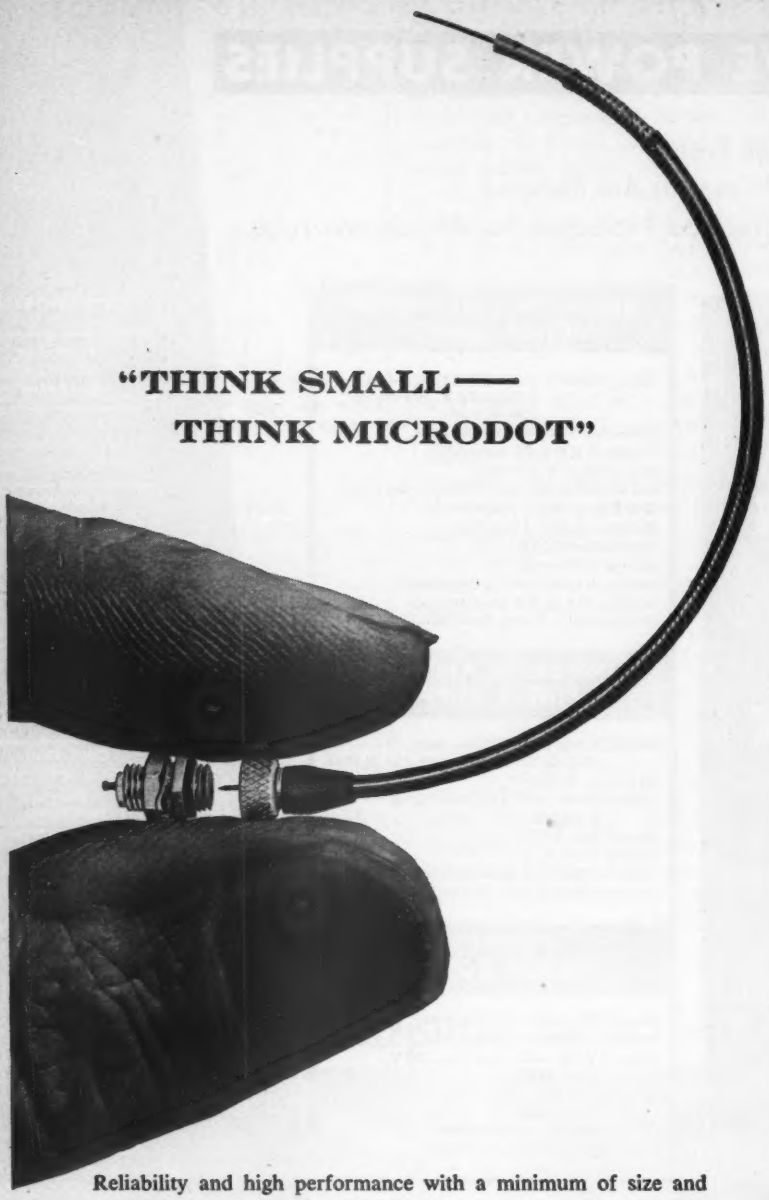

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tential in the cathode circuit of the neon tube may be found desirable. The shutoff pulse amplitude must always exceed the difference between the supply voltage and the extinction voltage (E_e) of the neon tube. Optimum shape for the triggering pulses is like that of a ripsaw tooth, with a sharp rise and a gradual decline.

Constant Duration Gate

Circuit of a neon-triode gate that gives an output pulse of constant duration through a wide range of input pulse-repetition frequencies is shown in Fig. 2. A relatively large capacitor is tapped along the anode resistor of the neon tube. When the tube fires, the capacitor discharges through the neon tube and resistor R_1 until the charge is dissipated. At that time, the neon tube goes out.

If anode triggering with a positive pulse is used and the pulse shape is not ripsaw toothed, operation can be improved by addition of a high back resistance diode, as shown in Fig. 2.

When the neon tube is not conducting, the capacitor recharges

Discharge Path Forms Tree

Mullard in England made this tree-like pattern with one of their linear accelerators. Electronics from the accelerator penetrated the polished surface of the plastic block causing a charge to accumulate inside the block. The charge was released by inserting a sharp pin in the bottom, resulting in the tree effect which shows the discharge path

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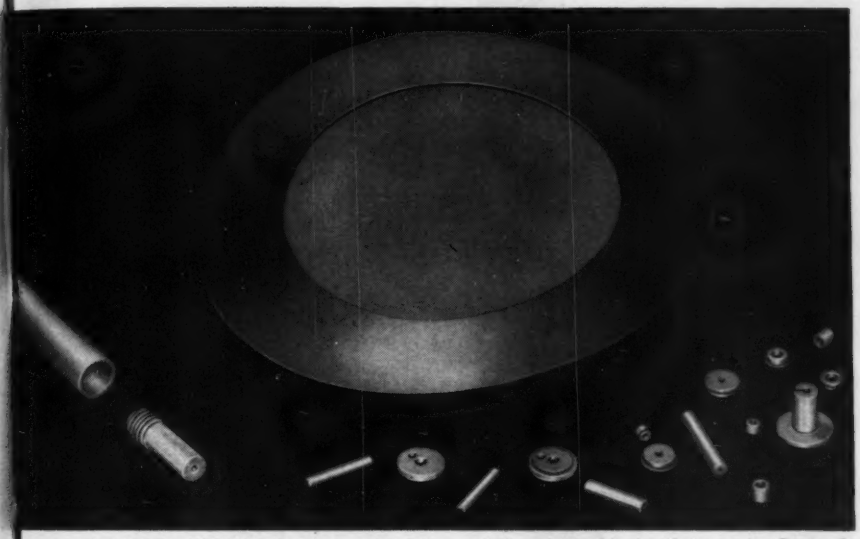

INSULATORS of TFE-fluorocarbon resins withstand severest climatic and flight conditions. High dielectric strength, moisture repellence, keep 1 KW of RF power isolated even in rarefied and humid air. (Antenna by Dorne & Margolin, Inc., Westbury, N. Y.; parts machined from TEFLON TFE-fluorocarbon resins by Tri-Point Plastics, Inc., Albertson, L. I., N. Y.)

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Insulation of TEFLON® resin permits soldering in tightly wired equipment

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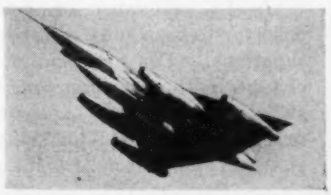
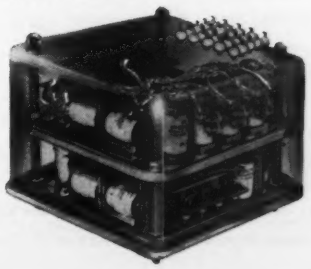
WIRE INSULATION and sleeving of TEFLON TFE-fluorocarbon resins permit tight wiring in this miniaturized relay unit for the supersonic B-58. (Unit by Potter & Brumfield, Inc., Princeton, Ind.; wire and sleeving by Warren Wire Co., Pownal, Vt.)





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through R_2 until its terminal voltage equals the supply voltage.

Best operation is secured with this circuit and its derivatives when resistance is kept high, capacitance low, and R_2 is very much greater than R_1.

Applications

Both circuits were developed for use with meteorological instruments. The first works extremely well with an inductance connected from trigger input to ground. The initial turning on of the trigger circuit supplies the start pulse, and the flyback from the inductance when the circuit is opened provides the shutoff pulse. The second circuit functions excellently as a pulse-stretcher. Within a wide range of trigger pulse repetition frequencies, the duration of the output pulse is always the same.

Diodes Offset Silicon Transistor Heat Drift

By **David H. Bryan**
Hawthorne, Calif.

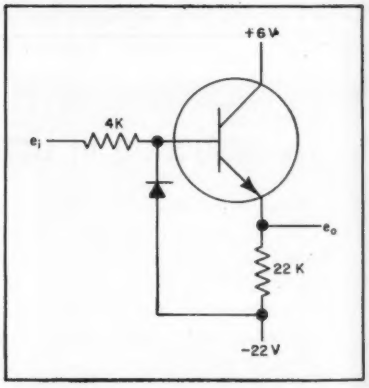

FIG. 1—Germanium diode with 4,000-ohm input resistor compensates drift in silicon transistor amplifier

IN BOTH germanium and silicon transistors, increased temperature decreases resistance of both the collector-to-base and emitter-to-base junctions. For germanium the change in the collector junction is sufficiently large to account for practically all heat drift effects. However, in silicon the change in

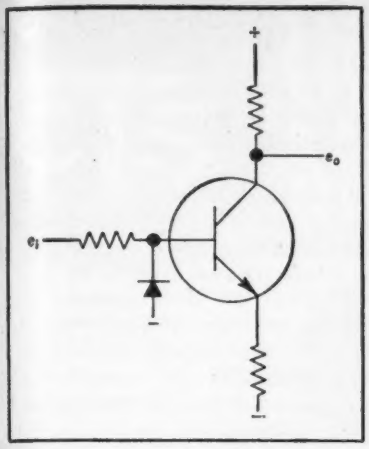

FIG. 2—If too much compensation results in this circuit, part of diode current can be bled to ground

collector-to-base junction resistance is practically negligible. The change in resistance of the emitter-to-base junction accounts for most of heat-drift effects. As a matter of fact the change in emitter-to-base resistance with changes in temperature is greater for silicon than for germanium because of the higher resistivity of silicon.

There are several methods of compensating heat drift in silicon transistor d-c amplifiers.

For an *npn* silicon emitter follower with 1-ma emitter current, output rises about 100-mv as room temperature rises to 55 C. This drift can be offset by adding a 4,000 ohms in series with the base and a back-biased germanium diode in parallel with the base. Over this temperature range diode current changes about 25 microamperes. This current through 4,000 ohms lowers voltage on the base 100 mv to provide compensation.

Using this network, the output variation with heat was found to be steady to within 10 mv. Since input impedance of the emitter follower is high, the 4,000-ohm resistor has little effect. The shunt diode offers about one-megohm resistance, which is also not significant.

A similar arrangement of compensation can be used for an amplifier circuit using emitter-resistor degeneration. If too much compensation results it is better to bleed part of the diode current to ground than to reduce the drop across the diode. This is because diode behavior is inclined to change operat-

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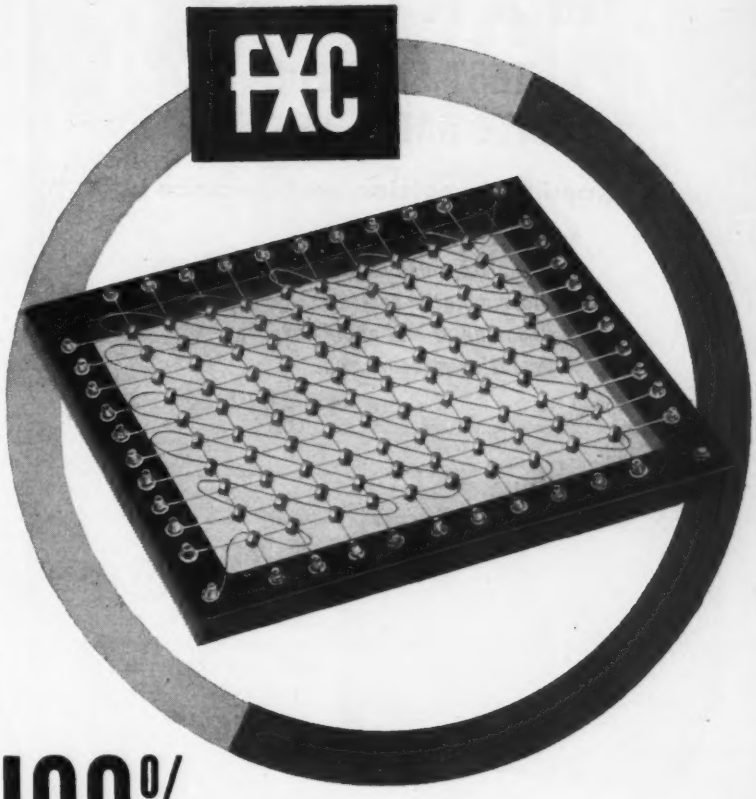

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ing point at low voltages but levels off at 20 volts or more. Hence more consistent behavior among diodes is obtained if the drop is maintained at twenty volts.

Applying this method to grounded-emitter transistor stages is not so effective unless several silicon diodes are used in series. In this type circuit the diode is in series with the collector and load resistor and is forward biased. The output can be thought of as the output of a two-input adding circuit comprising

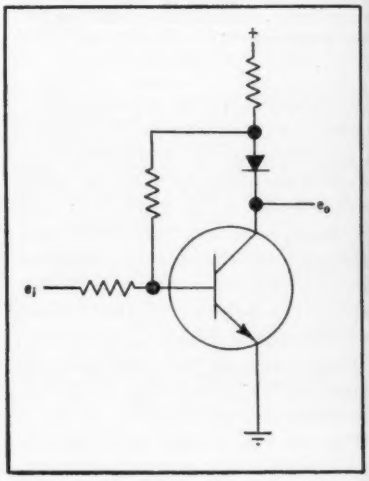

FIG. 3—Silicon diode with transistor junction form adder circuit to offset temperature drift

two diodes that drift the same amount with heat changes. However, the effect of each diode is opposite in sign and hence they tend to cancel.

A few rules of thumb should be followed in designing these circuits. Where a back-biased diode is used, it should be regarded as supplying a compensating current. This diode must be germanium since the leakage of silicon is negligible for these applications. On the other hand, when a forward-biased diode is used, silicon is a little better because there is more variation with heat. This diode should be regarded as a voltage source that provides a compensating voltage.

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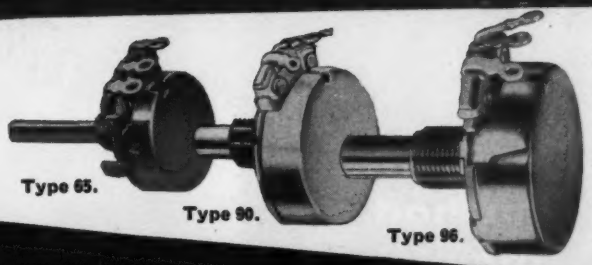

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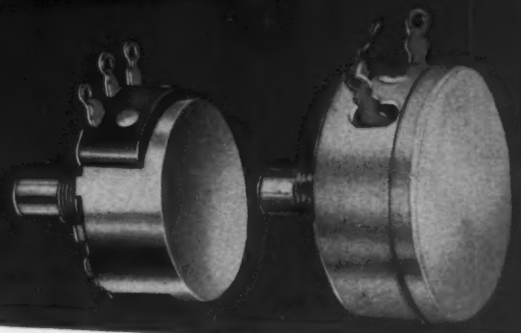

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Resistance Range (ohms)	3-15K	3-25K	X & Y	100-2.5 megs	100-5 megs	250-2.5 megs
Rotational Life	5% max, 25,000 cycles		X Y	10% max, 15,000 cycles 10% max, 25,000 cycles		
Load Life	3% max, 1,000 hours, rated load, 40°C		X Y	12% max, 1,000 hours, rated load, 70°C 10% max, 1,000 hours, rated load, 70°C		
Moisture Resistance	10% max, Method 106, MIL-STD-202, 3.5 megs min insulation resistance		X Y	10% average, 14% max, Method 106, MIL-STD-202, 50 megs min insulation resistance 6% average, 10% max, Method 106, MIL-STD-202, 100 megs min insulation resistance		
Low Temp. Storage	4% max		X Y	4% max 2% max		
Low Temp. Operation	4% max		X Y	4% max 3% max		
Thermal Cycling	4% max		X Y	10% max 6% max		
Acceleration	3% max		X & Y	3% max		
Shock	2% max		X & Y	2% max		
High Freq. Vibration	2% max		X & Y	2% max		
Temp. Range	–63°C to +105°C		X & Y	–63°C to 150°C		

Available also at CTS West Coast and Canadian subsidiaries' plants.

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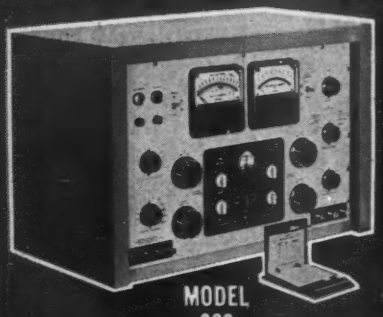
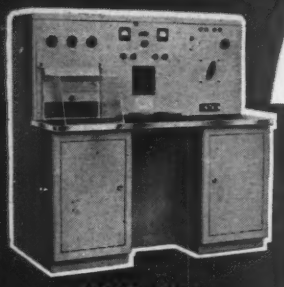


MODEL 829

Superior and sustained quality control, through frequent calibration of test instruments, can be achieved by semi-skilled personnel using these self-contained standards.

Portable Model 829 calibrates both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. Direct reading accuracy of 1% (0.5% using charts supplied). Output frequency from 50 to 400 cps depending on line frequency used.

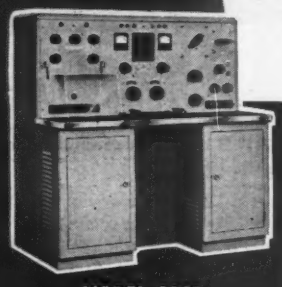
Net price $2,650.



MODEL 261B

Console Model 261B calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.

Net price $9,250.



MODEL 262B

Model 262B Dual Potentiometer Standard calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes. Employs Weston instruments and standard cells.

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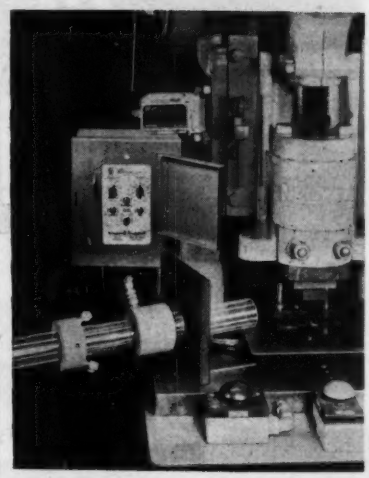

Punch press is stopped to avoid breaking die if punched piece is not ejected through r-f coil mounted on tube

presses is resulting in increased production.

Heart of the Robotron Corporation's die-saving device is a detector in the form of an r-f coil mounted on a cast acrylic tube. The detector responds when a stamped piece is not ejected by stopping the press from completing the stroke. This problem, called double heading, is a prime cause of die breakage.

The ejected piece is pushed through the tube by compressed air. As the piece goes through the r-f field, a relay is tripped. If a piece fails to pass through within a specified time, the relay contacts remain open and the press is stopped.

By eliminating double heading, less care is required by the operator. In addition, faster automatic feeds can be used.

A modification of the same detector can be used to count pieces.

UHF to Guard Fire Trucks

Transmitter Activates Lights at Intersection to Warn of Approaching Fire Vehicle

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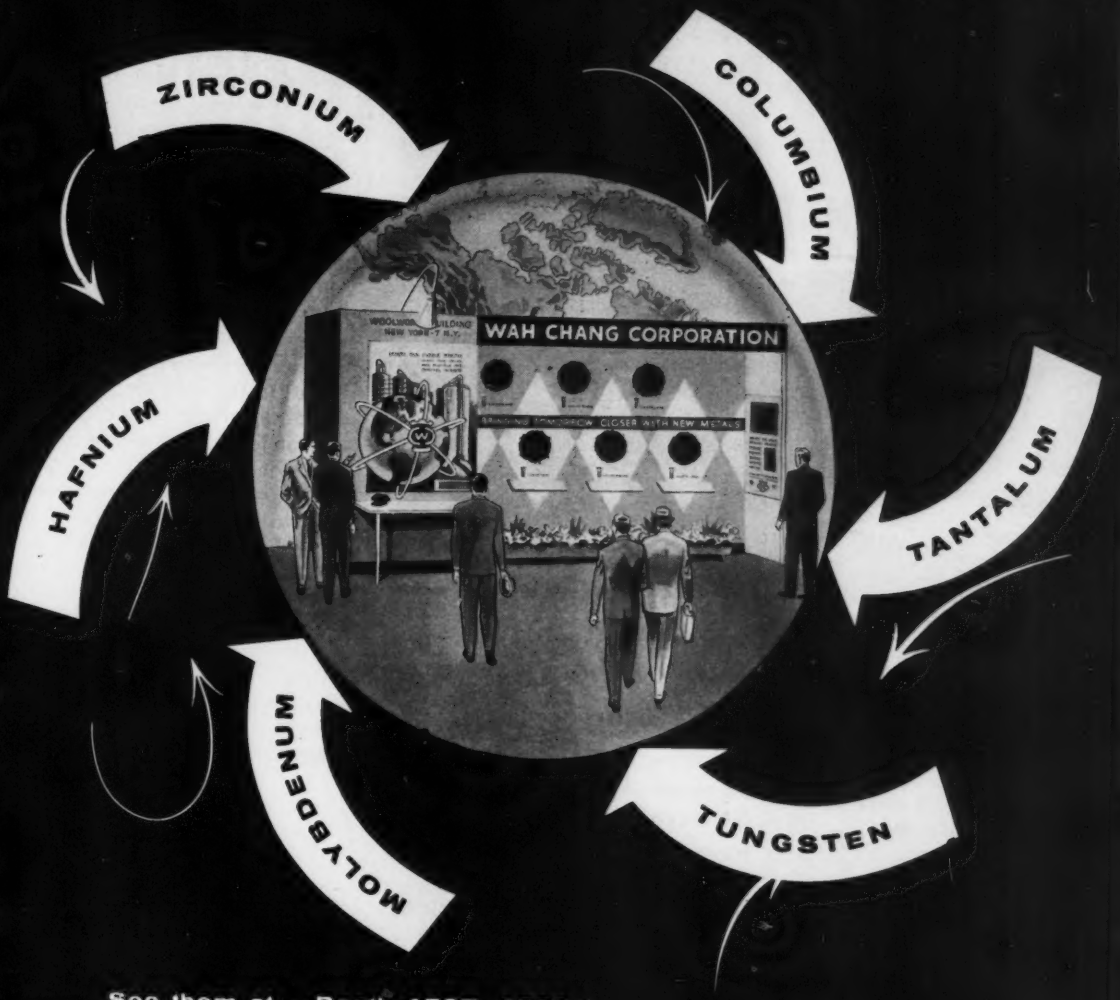

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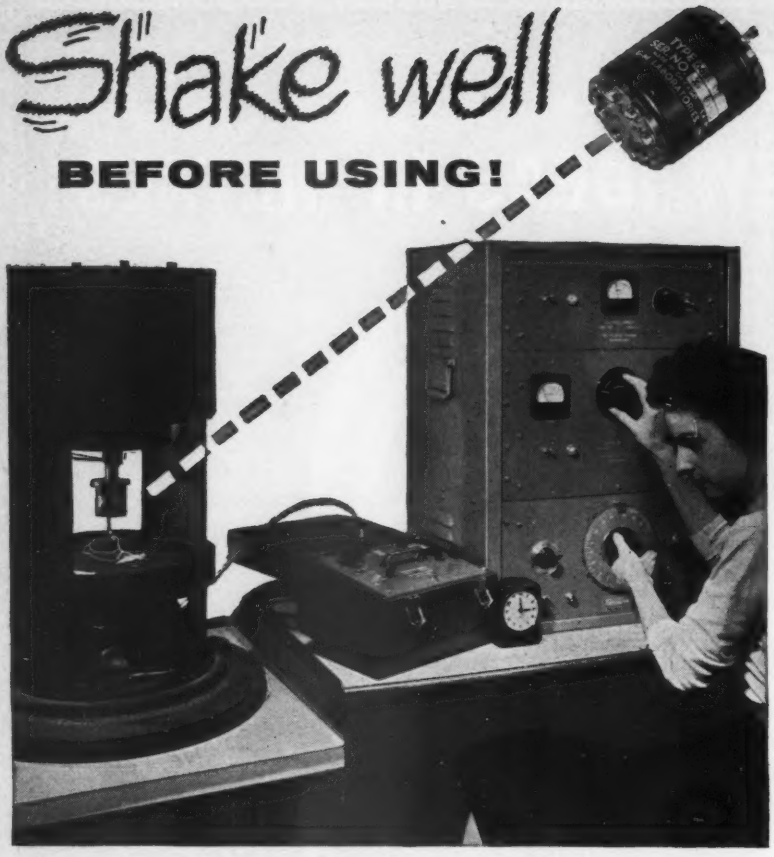

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operation of city's traffic light system, is expected to reduce accidents to fire equipment and to benefit motorists.

The system consists of a three-watt f-m transmitter that is installed on the fire vehicle and operated by the driver. It activates a red beacon and four yellow signal lights in a transistorized receiver located on poles near the intersection. Developed by the fire department radio division and built by Motorola, the system uses a dual-tone decoded signal and carrier and is expected to operate on a frequency around 900 mc when final plans are adopted.

The transmitter generates sinusoidal tones in audio band along with the carrier to ensure signal capture by two-reed decoders employed in the receiver. Upon signal decoding, relays are energized to activate either red beacon or yellow lights or both.

The two-reed decoders are necessary to handle two pairs of dual-tone decoded signals, North-South and East-West, which are generated upon manual operation of two toggle switches on the transmitter panel. Operation of the N-S or E-W switch results in activation of the yellow lights facing in the selected direction. The succeeding switch operation causes deactivation.

Tv Controls Traffic

Bobby controls traffic lights by watching monitor as closed-circuit tv cameras see vehicles around bends and over bridges in Durham, England

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COMPONENT DESIGN

Transistors After Ten Years Of Development

Tenth anniversary of a little transistor which performs like a giant, invented by a little man who thinks giant thoughts. Left to right: Dr. G. P. Harnwell, President of the U. Of Pennsylvania; Dr. William Shockley, Noel Laureate, and Dr. J. H. Milligan, Jr., Chairman of the 1958 Transistor and Solid State Circuits Conference

IN THE TEN YEARS since Bell Labs announced its invention, the transistor has risen from an impractical 25 mw laboratory device to one of the most widely used components in electronics.

More than 28 million were sold last year at an average cost of $2.40 each. This price was twenty percent lower than the previous year. Dr. William Shockley has said he thinks a reasonable estimate for average cost five years from now is about twenty-five cents.

Transistor theory of a decade ago offered no promise for high frequency operation. One kilo-megacycle transistors are available today, and there is no reason to doubt that this will go up to ten kilo-megacycles in five years, and 100 kilo-megacycles in ten years. Limits set by the atomic structure have hardly been approached.

Can We Do It

As in all things, these advances will require a thorough analysis of the problems by imaginative men confident of their abilities. The papers delivered at the 1958 Transistor and Solid State Conference in Philadelphia, and the ambitious attitude of men attending the conference dispel any doubts on this count.

Many new materials and techniques for building transistors which operate a 500 mc or higher, were discussed at the conference. General feeling was that a very rapid birth of ideas will continue for at least the next few years.

In the final analysis, however, regardless of what secondary techniques are used, high frequency limit is determined by transistor geometry. Transistor dimensions determine the transit time which sets the theoretical high frequency limit for a particular material.

In a paper delivered at the conference, Dr. Shockley compared the advances made in transistor frequency response with changes in construction. Point contact transistors had the collector and the emitter mounted in the base in close proximity to each other. The ability to physically place the collector and emitter in the base without having them touch was the limiting factor.

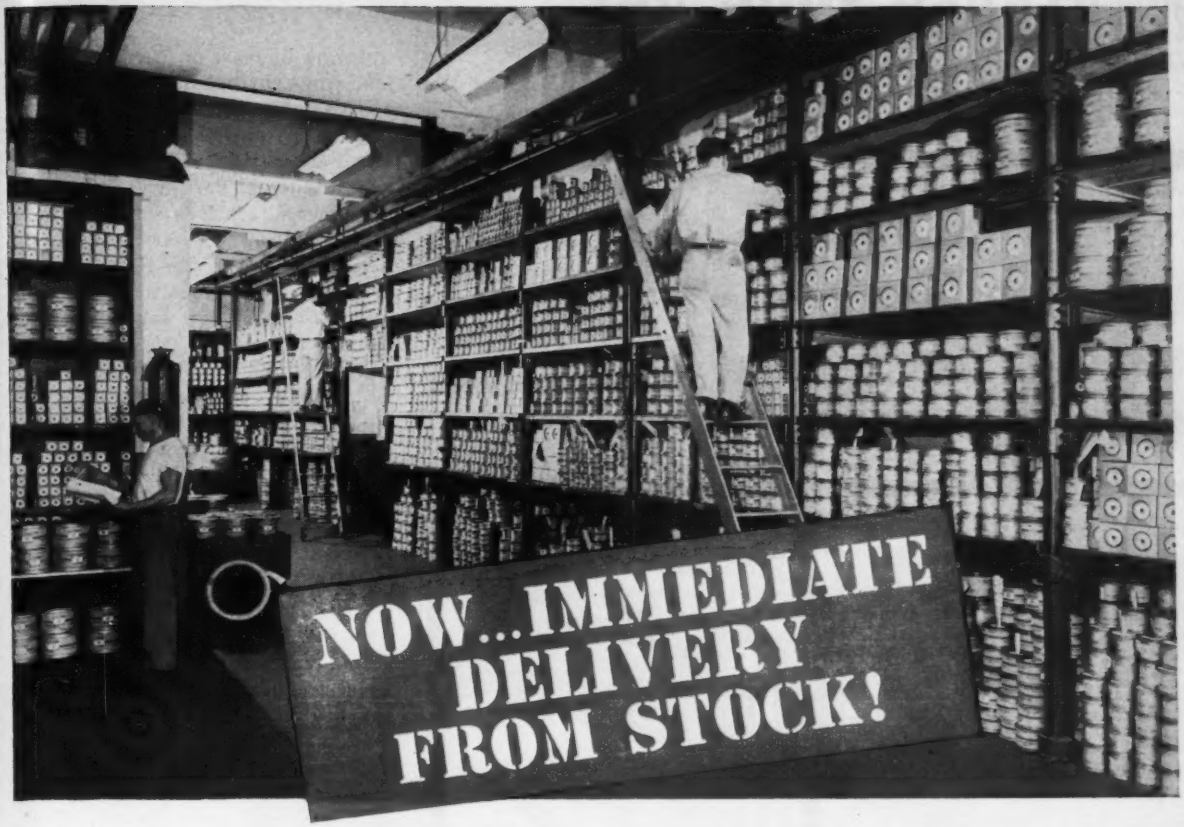
Junction transistors were a tremendous improvement over the point contact type. N and P materials in the junction transistor are joined in one crystalline structure, with continuity of the crystalline lattice maintained across the junction. Dimensional control possible with materials grown into one crystalline structure is obviously much better than would be possible by placing the two elements near each other.

Increased knowledge in semiconductor physics, especially at the P-N junctions, and the development of new materials have resulted in the constant improvement of junction transistors. Many of the techniques now under investigation to improve transistors will have a short life. Some will probably never reach the practical stage. Time and competition will determine which approaches are best.

Dr. Shockley feels that one of the final solutions will be to eliminate the base connection entirely, and supply the transistor with an external d. c. Commercially available transistors up to this time have all been three element devices requiring connections to each element. He feels that the junction size necessary to attach a lead to the base connection is too large for high-frequency development.

A transistor diode originally developed at Bell Laboratories is now in pilot production at the Shockley Semiconductor Laboratory of Beckman Instruments Inc. It has a negative resistance (i.e. will produce amplification) when the proper dc bias is applied to it.

The negative resistance results when excess electrons or holes crossing a P-N junction with a high reverse bias generates secondaries which form an avalanche multiplication. Matching the characteristics of the deathnium centers to the properties of silicon



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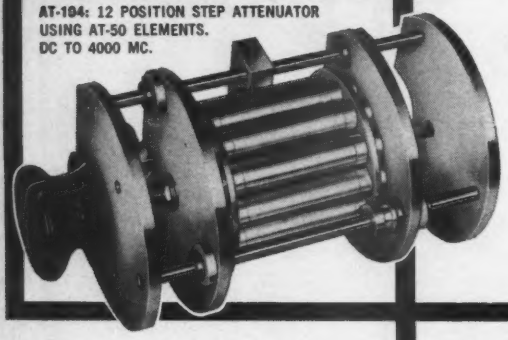
AT-104: 12 POSITION STEP ATTENUATOR
USING AT-50 ELEMENTS.
DC TO 4000 MC.



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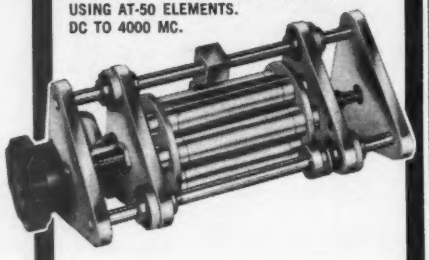
Empire's UHF attenuators are resistive coaxial networks for the frequency range from DC to 4000 MC.

Accuracy is held to ±½ DB, VSWR is better than 1.2 to 1. Any attenuation values up to 60 DB are available. Deposited carbon elements are used for stability and operations at higher pulse levels. Standard impedance is 50 ohms, other values upon request. These units have excellent temperature characteristics and are vibration and shock resistant. Standard connectors are type "N", attenuator pads are also available with type "C".

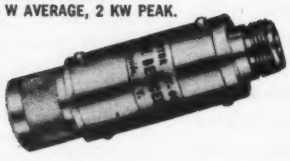
The attenuators may be obtained as individual pads (AT-50, AT-60), or as multi-position step attenuators AT-103 (six positions) and AT-104 (twelve positions). For even greater flexibility, several step attenuators may be series connected.

AT-103: 6 POSITION STEP ATTENUATOR
USING AT-50 ELEMENTS.
DC TO 4000 MC.



AT-50: ATTENUATOR PAD,
DC TO 4000 MC.
1 W AVERAGE, 1 KW PEAK.

AT-60: ATTENUATOR PAD,
DC TO 3000 MC.
2 W AVERAGE, 2 KW PEAK.



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aids the increase in carrier injection when current in the P-N junction is increased.

Only the dimension of the transistor diode which is in the direction of current flow must be small. All other dimensions can be large. Since it is not necessary to connect a lead to any of the larger junctions, the dimensions in the direction of current flow has no physical limitations.

Stable high gain amplifiers can be made by combining transistor diodes and gyrators. Shockley claims that less expensive, higher performing digital computers made of only transistor diodes and ordinary diodes are possible.

New Companies Needed

Organization of a few companies with the sole function of manufacturing semiconductor crystal material would be a great boom to the transistor industry. Starting point for a good deal of development work, which must be done on semiconductor devices, is a thin slice of a semiconductor crystal. The equipment necessary to produce crystals without imperfections, and with accurately controlled impurity concentrations is very costly. Suppliers who would sell semiconductor crystals to companies not able to absorb the initial equipment cost are needed in the industry.

It is also possible that instead of growing massive crystals and slicing them—a process in which most of the crystal ends up as dust—machines could be developed to grow plates. The plates which would be the same thickness as present-day slices would be better suited to mass production techniques.

Practical Production

Dr. Shockley made a statement in his talk which summarizes very well the practical position of transistor development:

"If any area is weak, it seems to me to be along the border line between exploratory research, with knowledge as an adequate goal, and development for production, with the aim of finding a useful production process, whether or not understood. I believe the field

Now...a battery of Hydroforms at

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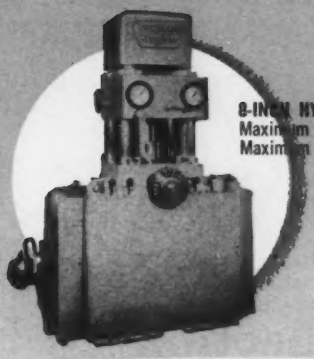

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Maximum Draw Depth — 5"

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FEWER DRAWING OPERATIONS
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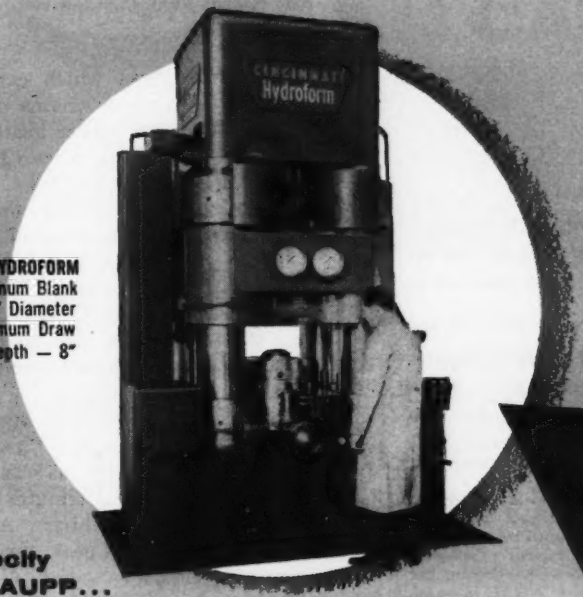

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Maximum Blank
19" Diameter
Maximum Draw
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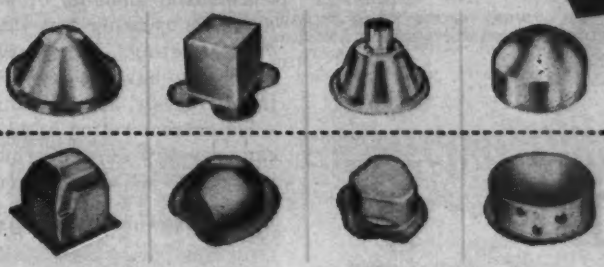

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12-INCH HYDROFORM
Max. Blank — 12" Diameter
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Thermally stable. D-B seals will not fracture in desert or arctic climates . . . will withstand degassing by baking. Units are vacuum-tight . . . shock and vibration proof. Seven standard sizes cover the entire microwave and ultra-microwave range.

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Type Windows: Metal-glass-mica, optically clear.

Size Range: 7 standard sizes cover from 8.2 to 90 KMc.

Temperature range: −55°C to +100°C.

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would advance faster if somewhat more fundamental understanding were sought for the processes likely to be useful in production."

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Silicon diodes joined together to make a High Voltage Rectifier at low cost

SILICON RECTIFIERS which can be assembled into series chains make high-voltage rectification available at a mass production price. Inexpensive threaded bushings are used to screw the required number of individual units end-to-end.

The rectifiers produced by the Rectifier Division, Audio Devices, Inc., 620 East Byer Road, Santa Ana, California, can also be used singly for low and medium-voltage applications.

A rectifier with a peak inverse rating of 12,000 v and a forward current rating of 500 ma can be made in about ten minutes by screwing together thirty A750 units, which have a peak inverse rating of 400 v.

High Power

Substantial amounts of power are available by using unit with higher current ratings. Thirty 40F1 units, which also have a peak inverse rating of 12,000v, and a maximum forward current rating of 1½ amperes can provide 6 kw of rectified power in a single-phase half-wave circuit.

Maximum Ratings

Individual units now available for the expandable rectifier are sealed silicon diodes with peak inverse

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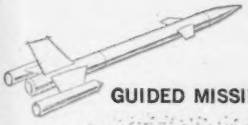
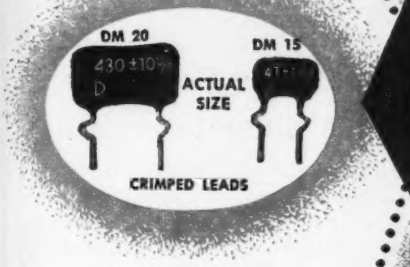
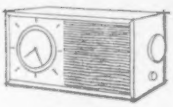


GUIDED MISSILES





RADIO

TELEVISION

COMPUTER

El-Menco *Dur-Mica* CAPACITORS

Wherever your specifications call for long-lived *miniaturized reservoirs*, El-Menco Dur-Mica Capacitors offer **PRE-PROVEN LIFE EXPECTANCY OF UP TO 20 YEARS.** These mighty midgets carry mammoth loads for *lasting* peak performance . . . guarantee you confident, worry-free planning.

All these points make El-Menco *Dur-Micas* DM15, DM20, and DM30 the finest obtainable.

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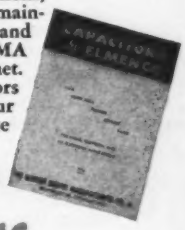
2. POTENT POWER
3. SMALLER SIZE
4. EXCELLENT STABILITY — SILVERED MICA
5. PEAK PERFORMANCE

Extra-tough phenolic casings prolong life, increase stability over wide temperature range.

Recent comparison tests of El-Menco DM15, DM20 and DM30 Dur-Mica Capacitors showed them to be longer-lived, more fatigue resistant than any others. Under stepped up conditions of 1½ times rated voltage at 125° C ambient temperature, each in turn achieved above standard ratings of undiminished performance well past 16,000 hours, or, under normal conditions, a projected working lifetime of from 15 to 20 years!

Simple 'hairpin' design facilitates use in tight spots in television, radio, computers, miniature printed circuits, guided missiles, hearing aids and countless civilian and military applications, with little or no replacement and maintenance cost. All environmental and electrical requirements of RETMA and MIL C-5 specs have been met. Test El-Menco Dur-Mica Capacitors for yourself with our help. Our engineering staff is at your service upon request.



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El-Menco *Capacitors*

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

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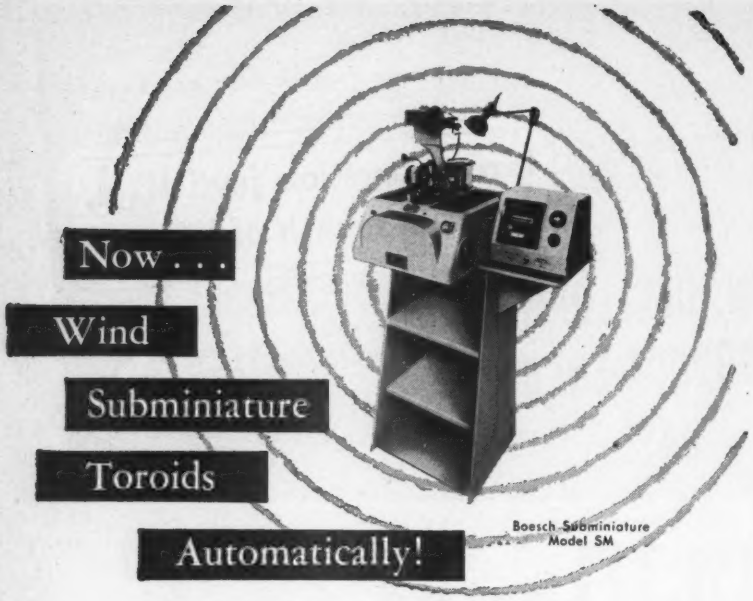

Smaller toroids facilitate new designs — open new channels to the coil winding industry

Think of the space . . . weight . . . design problems solved by this machine. Coils with IDs of just 1/16" . . . maximum ODs of 3/4" . . . heights to 1/2" wound automatically with wire sizes as fine as #50! Winding speed is continuously variable from 0 to 800 turns per minute and machine equipment includes every accessory you'll need. Reversing mechanism, wire spacing and core rotation direction controls, wire tension device, automatic linear counter, for example, are just a few of the "custom extras" included as basic parts on Boesch SM. The flexibility offered by this revolutionary machine opens fresh new horizons to the coil winding industry. Get complete details on this Subminiature and all Boesch machinery now. Write today for Catalog 57A.

All Boesch Toroidal Winders . . . Fully-Automatic TW 200, Semi-Automatic TW 201 and Subminiature SM feature modern, adaptable design, easy operation, high speed and life-time parts lubrication.

Comparison is the best test of excellence. See for yourself why Boesch manufactures the world's most superior winding machines.

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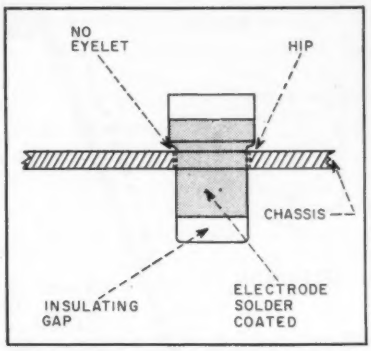
ratings ranging from 100 to 400v and maximum forward current ratings ranging from 500 ma to 1½ A.

Assemblies can be rated at the product of the number of units times individual peak inverse ratings, without derating. A negative temperature coefficient of resistance gives a self balancing effect which tends to keep the voltage evenly distributed over the units in the chain, to limits well within the unit ratings. Up to about 20,000v the assemblies offer simple, inexpensive rectification. At higher voltages, precautions have to be taken to control corona and ionization.

Hip Mount Capacitors Save Space

DESIGNED TO SAVE SPACE and reduce assembly costs, the feed thru capacitor is particularly useful when compactness is an essential part of equipment design. The units are 3/8 in. long, and protrusion from the chassis plane is only 3/64 in.

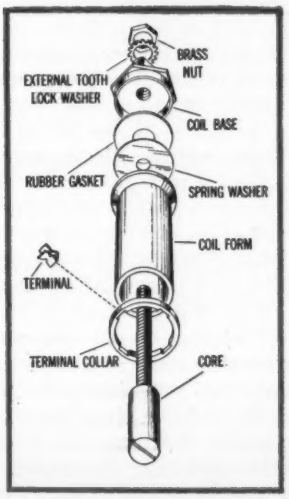


Hip keeps capacitor at uniform height and snug in hole

The CFT capacitors, designed by Cornell-Dubilier Electric Corp., South Plainfield, N. J. are self-positioning. The hip-ridge, holds insertion of the capacitor in the chassis hole to a fixed, always-uniform distance. No jigs are needed to maintain position for soldering the capacitor to the chassis.

The capacitor electrode is hot-solder coated. This feature permits the capacitor to be soldered to the

UNIVERSAL CERAMIC COIL FORMS FOR MILITARY AND COMMERCIAL APPLICATIONS



National Company, one of the nation's oldest suppliers of quality coils and coil forms, now introduces, for immediate delivery, a new line of ceramic coil forms, engineered to meet the most rigid military and commercial applications.

Available in 5 standard sizes, with or without terminal collars. Terminal collars accept up to four terminals per collar.

Internal, pre-set torque spring provides smooth, vibration-proof means of positioning and locking the adjusting cores. Keep coils tuned as set, even under severe vibration and shock.

Powdered iron cores available in choices of standard and long-core lengths. Color-coded to indicate optimum frequency ranges.

All material used are in accordance with applicable MIL-Specs.

Coil forms, collars, and terminals available at your National Parts Distributor. Coil forms supplied with spring washer, rubber gasket, coil base, external tooth lock washer and brass nut. Cores may be ordered from National Company. Pre-assembled forms to your prints quoted by National Company upon request.

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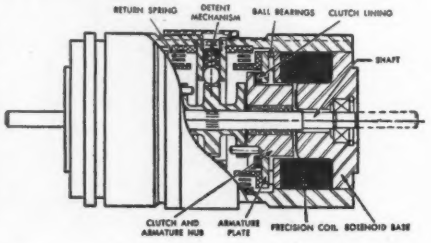
NEW! Syncramental motor provides precise bi-directional stepping

ACTUAL SIZE

The *Syncramental* Motor accurately translates pulses to incremental shaft position for conversion of digital information to analogous shaft displacements. Compact, long-life power can rotate potentiometers, counters, rotary switches, control mechanisms.

A special magnetic clutch mechanism, rather than ratchets, indexes the shaft. Clutch and detent mechanism are mounted between two LEDEX Rotary Solenoids whose armature plates face each other. Clutch rotates with one or the other of the energized armatures, to which it has been magnetically attracted, causing shaft rotation. Solenoid de-energizing returns the armature to original position, but clutch and shaft are held in displaced position by the detent.



PERFORMANCE: Angular increment per pulse—36° (either direction). Detent accuracy—±½° under no load conditions. Maximum stepping rate—15 per second. Load capacity—up to 2 lb. in. starting torque at 20°C. Life expectancy—2 million steps in either direction.

ENVIRONMENTAL CONDITIONS: Temperature—minus 55°C. to 120°C. Altitude—up to 90,000 ft. Meets applicable requirements of MIL-E-5272A.

SIZE, MOUNTINGS: Dimensions—1.500" dia. x 2.525" long. Weight—13 oz. Mountings—standard Servo.

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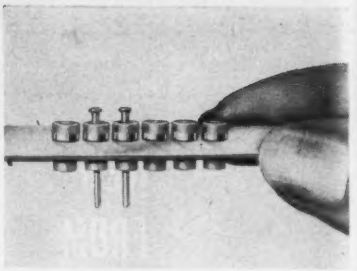
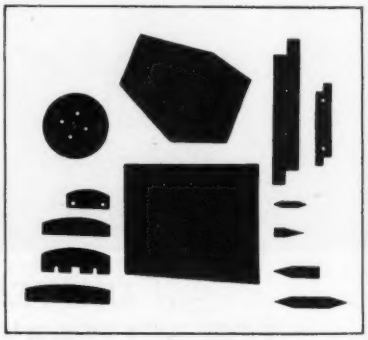


Feed-thru capacitor saves space and lowers assembly cost

metal chassis, eliminating use of eyelet fasteners.

Type CFT capacitors have a d-c working voltage of 600 v and are available in capacitance values from 4.7 $\mu\mu$f to 1000 $\mu\mu$f. Diameters of the head and shank ends are $\frac{7}{32}$ in. and 9.187 in. respectively. Operating temperature range is −55 C to +85 C.

Metal Film Mica Attenuators



Metal film mica can be easily cut into any desired shape

HIGHLY stable microwave attenuators, made of a thin film of pure metal deposited on scratch-free mica a few thousands of an inch thick, reduce RF leakage. Small size of a metallized mica high frequency variable attenuators permits a smaller slot width for guillotine design. This is desirable since RF leakage at the slot affects attenuation characteristics.

Electrical and environmental characteristics of the attenuator, developed by Filmohm Corporation, 48 W. 25th St., New York 10, N. Y., compare favorably with metallized glass elements. The metal film is

sealed with a micro thin protective coating of Quartz.

Another application of mica is in rotary attenuator design which uses 0.001 thick mica sections, electrically matched at either end. Standard mica sheets are available from 0.001 to 0.005 in. thick, and in resistivities from 25 to 400 ohms per square. Elements can be hand cut to customer requirements and an instruction bulletin is available which details a method of hand cutting eccentric shapes.

New Components May Double Radar Range

DOUBLE the range and accuracy of antimissile radars is the goal of an all-out effort by Sperry Gyroscope. Practical application in specific U. S. missile systems of some of the newer microwave elements is the basis of the program.

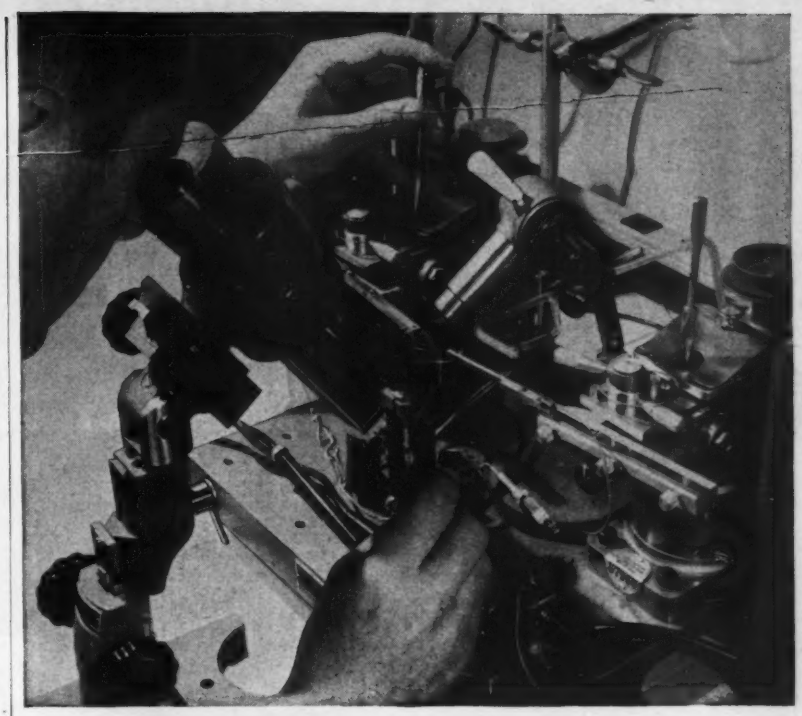
The firm will organize an additional applied physics laboratory for new microwave solid-state devices for missiles. Thirty scientists from Sperry plants will start the study with a three-day seminar to examine current progress in the field.

E. J. Venaglia, manager of Sperry's microwave electronics division, points out that although essential theory and phenomena have been known for years, many of the devices that could improve radar have remained laboratory curiosities.

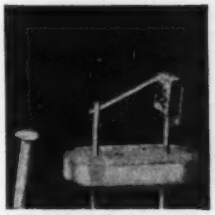
The application of semiconductor and ferromagnetic materials as concentrators, manipulators or generators of radar energy will be investigated. These devices include passive ferrite circuit elements, masers and parametric oscillators.

Preformed Contacts for Printed Wiring

INCREASED RELIABILITY has been attained in the fabrication of photoetched, copper-laminated, printed circuit boards by the use of preformed contact strips and a solder-coating. Developed jointly by Her-



3-D MICRO-VISION
helps RAYTHEON develop new
SPACISTOR amplifier



Spacistor shown next to ordinary pinhead.

The Spacistor, Raytheon's new semiconductor amplifier, opens new horizons in missile and communications equipment design. Still in development, the Spacistor promises to combine many advantages of transistors and vacuum tubes.

Viewed through a Bausch & Lomb Stereomicroscope, contact points that are normally barely visible can be positioned with hairline accuracy. 3-D magnification shows all parts vividly, right side up. Long working distance permits free movement of hands and tools between eyepiece and stage. Dustproof, shockproof optical system, with sharp, flat images free from distortion, assures fatigue-free viewing throughout prolonged examination.

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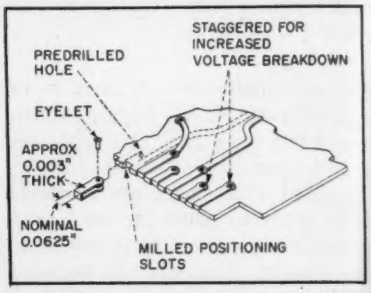
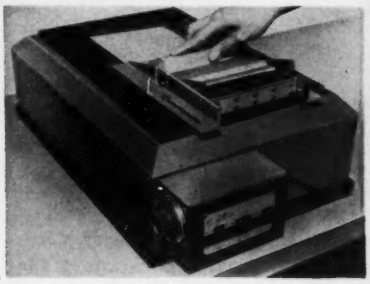
LAPP MULTIPLE-CONTACT PLUG RECEPTACLE UNITS FOR SECTIONALIZING CIRCUITS

These plug-and-receptacle units are used for panel-rack or other sectionalized circuits where a number of connections must be made or broken. Any number of contacts can be provided (in multiples of twelve). Male and female contacts are full-floating for easy alignment and positive contact. Contacts are silver-plated brass and phosphor bronze with terminals tinned for easy soldering. Ceramic blocks are steatite, white glazed . . . non-carbonizing even under leakage flashover caused by contamination, moisture or humidity. Write for specifications of available units or engineering recommendations for your requirement. Lapp Insulator Co., Inc., Radio Specialties Division, 140 Sumner Street, LeRoy, New York.

Lapp



U-shaped copper contact strips anchor printed circuit conductors at mating edge of board



Silicon-rubber squeegee is used after solder bath to provide smooth coating on conductors

bert Winsker and Horace L. Walters of the Norden Laboratories Division, Norden-Ketay Corp., White Plains, N. Y., these techniques have been applied to printed circuits for military applications.

U-shaped beryllium copper contact strips are positioned in milled slots along the board's mating edge and secured either by eyeleting or riveting through previously punched holes. The positioning slots are cut during the key-slot milling operation, avoiding an additional operation.

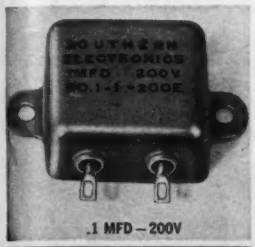
To provide a superior conductive and protective coating, the strips can be plated before assembly. Additional strips can be added conveniently at any time to accommodate new circuit requirements. The metal strips, while providing a more positive contact with the receptacle, will not loosen after long usage. Since eyelets can be used to secure the strips, the technique is especially suited to double-sided circuit board designs where eyeleting is a normal method of completing the circuits from one side of the board to the other.

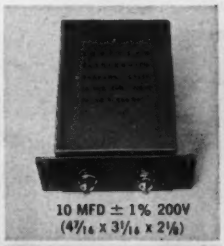
The technique provides simpler etching in less time and money.

where precision counts—it's S.E.C. first!

PLASTIC PRECISION CAPACITORS

Tubular .1 MFD – 200V

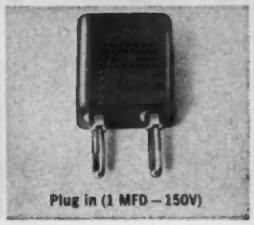

.1 MFD – 200V


10 MFD ± 1% 200V
(4⅞₁₆ x 3⅛₁₆ x 2⅛)

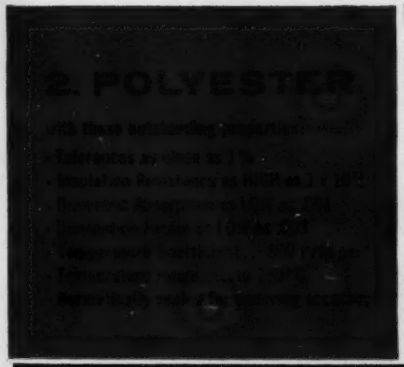
5 MFD

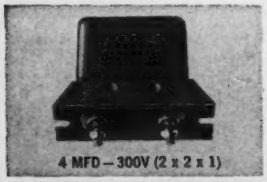
1 MFD – 200V

Adjustable

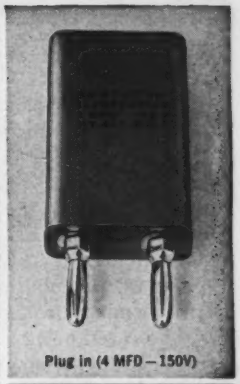

Plug in (1 MFD – 150V)

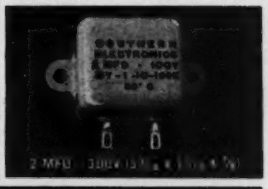
1. POLYSTYRENE

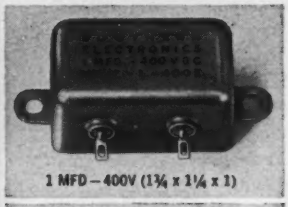

2. POLYESTER


4 MFD – 300V (2 x 2 x 1)

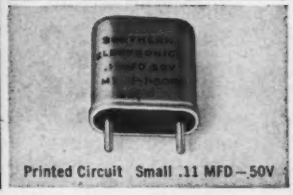
120 MFD ± 10% 50V


Plug in (4 MFD – 150V)

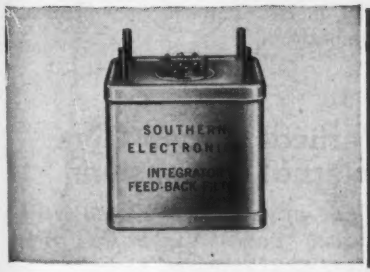

2 MFD


1 MFD – 400V (1¾ x 1¼ x 1)

.01 Tubular


Printed Circuit Small .11 MFD – 50V

10 MFD 100V (2 x 2 x 1⅛



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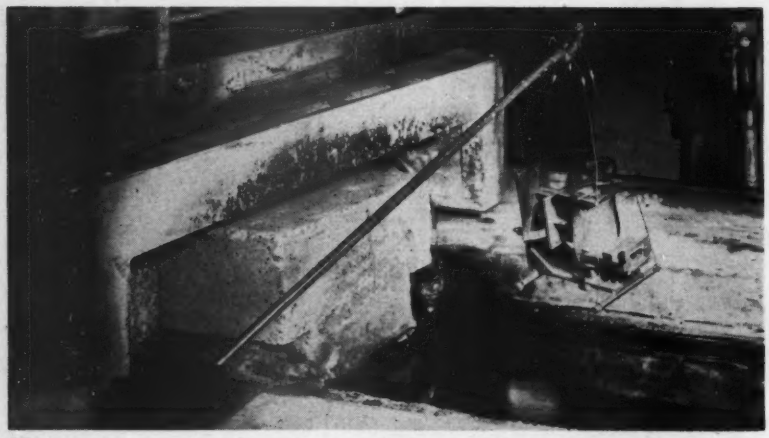
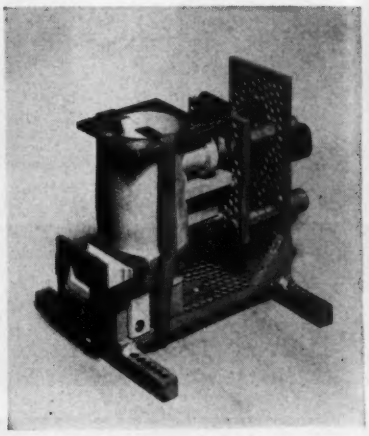
Dip-Brazing Eases Machining of Complex Parts

By **JOHN GOMBOS** John Gombos Co. Irvington, N. J.



Klystron tube mount in holding fixture is lifted from molten salt bath. Operator uses "fishpole" to avoid 1,100 F heat



Spring-loaded fixture holds mount together during brazing

ALUMINUM DIP-BRAZING simplifies fabrication of complex components and permits fuller use of aluminum parts of varying thicknesses, shapes and alloys. The method opens up design possibilities prohibited by more difficult methods.

A klystron tube mount made by John Gombos Co., Irvington, N. J., is dip-brazed of 12 parts machined from wrought stock and 2 cast parts. It was formerly produced as a casting, which made finish machining very difficult.

Mount parts are now finish machined before assembly and carefully deburred. Burrs or imbedded grit will block the brazing material, which flows into joints by capillary action. Joint strength results from surface penetration.

Soil and oxides are removed by vapor degrease and chemical treatment. A dip in hot sodium hydroxide and rinse is followed by a dip in nitric-hydrochloric acid, cold and hot rinse.

Parts are assembled in a fixture, with brazing shims and formed wires in place at the joints. The proper amount of brazing material to produce a clean, well-filled fillet with no overflow is determined by trial.

Fixture accuracy is critical. Stainless steel or Inconel must be

Cast and machined parts in front of assembled mount

used to avoid contaminating the salt bath. Massive parts (of the fixture) are lightened by drilled holes to avoid heat distortion, maintain salt temperature, reduce salt dragout and hasten heating and cooling. Parts are not allowed to butt against a solid wall. Spring-loading the fixture holds parts rigidly in place to maintain tolerances of 0.002 inch.

After fixturing, the assembly is preheated in an oven to 1,000F. It is then immersed in the molten flux salt. The salt bath is held within 2 degrees of 1,100 F. The maximum permissable temperature variation is 5 degrees.

Depending on massiveness of the parts, time in the bath may be 10 seconds to 3 minutes. Timing is determined by trial. The tube mount requires 30 seconds for brazing.

The brazed assembly is cooled at room temperature to 200-300 F. A boiling water dip removes most of the salt. Remaining salt is removed by dipping in nitric-hydrochloric acid, cold and hot water. All salt must be removed as its chlorides and fluorides would cause corrosion later.

Joints may be pressure-tested or inspected visually. Since just enough brazing alloy is used to produce a satisfactory joint, an excess visible at any point may indicate a void.

Only recommended alloys are used for dip-brazing. The salt is available from Alcoa and other companies. The salt bath must be periodically tested for contamination, moisture and proper chemical composition.

Vertical X-rays Give Internal Dimensions

X-RAY METHOD devised by Howard Harlan, Dalmo Victor Co., Belmont, Calif. enables accurate internal measurements of waveguides and other components to be made directly from film. Inside contours, iris positions after r-f tuning tests, blind holes and similar dimensions have been measured

New polyclad insulation eliminates core taping

(Left) New Polyclad resin provides complete insulation, eliminates taping required for former uncoated core (shown above).

This excellent insulation, added to the unique properties of Hipersil® cores—highest permeability with lowest loss, 100% flux carrying activity, lowest volume and weight—means a better foundation for better transformers . . . smaller, lighter, more efficient, and at a lower unit cost.

Positive protection against the effects of humidity and high-voltage stress, new Westinghouse Polyclad resin coating eliminates the need for taping the core or encasing it in a plastic or aluminum box—*insulation costs are reduced 15%*. The resin forms a smooth, continuous coating; rounded corners prevent shorting wire to core, allow winding directly on core. Strains induced into the magnetic core are much less than with ordinary insulation—magnetic values stay constant.

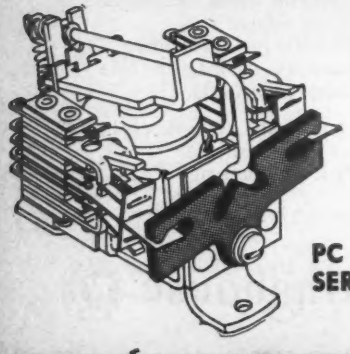
For more information about Polyclad insulated Hipersil cores—and other Hipersil cores, as well as the complete line of Hipermag® and Hiperthin® cores—call your Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 231, Greenville, Pennsylvania. J-70820

YOU CAN BE SURE...IF IT'S Westinghouse

P&B PROGRESS/

NEW! INGENIOUS IMPULSE LATCHING RELAY

NOW! TWO-COIL PERFORMANCE AT SINGLE COIL COST!



PC SERIES

This new series, the PC, is an ingenious impulse latching relay which employs a single coil and armature to activate an insulated rocker arm. Switching is positive, fast (30 milliseconds).

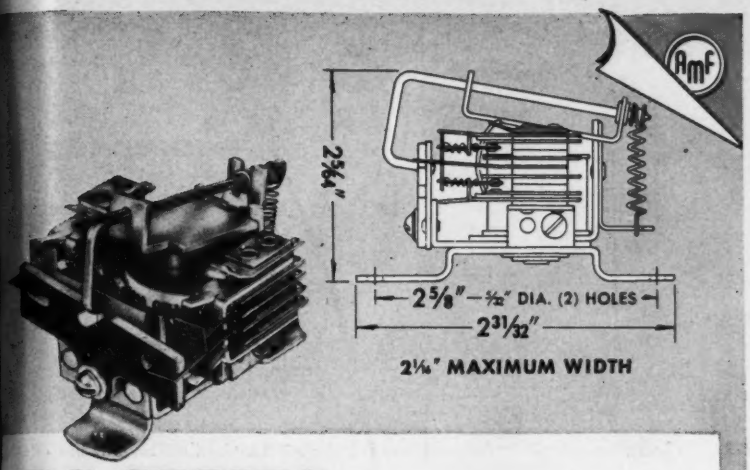
Its low cost, dependability and versatility make it ideal for a wide range of uses. For example, two leading TV set manufacturers use the PC in their remote control circuits as an "off-on" switch. It is also used by a maker of automatic garage doors. Conveying systems, automatic processing equipment, flow controls—the PC is right for these applications and many more.

Contact arrangements are available up to 4 Form C (4PDT), and the snap-action contacts are rated 5 amps. at 115 V. AC resistive. The relay may be ordered open, as shown, or in a metal dust cover.

Write or wire today for complete information.

See What's New in P&B Progress at Booth 3904-3906 IRE Show, New York City, March 24–27

POTTER & BRUMFIELD, INC., PRINCETON, INDIANA / SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY



PC SERIES ENGINEERING DATA

GENERAL: Description: Single coil, impulse latching relay.
Insulating Material: Laminated Phenolic.
Insulation Resistance: 1500 megs. min.
Breakdown Voltage: 500 V. RMS.
Ambient Temperature: —55° C. to +85° C.
Weight: 5 ozs. (open)
Pull-In: DC, 75% } for nominal voltage.
AC, 78% }
Operate: 30 MS.
Terminals: Pierced Solder Lugs
Coil: Two #20 AWG Wires
Contacts: One #20 AWG Wire
Enclosures: "A" Can.

CONTACTS: Arrangements: 4 Form C. max. (4PDT)
Material: 1/8" dia. Silver Cadmium oxide gold flashed.
Load: 5 amp. @ 115 V. AC resistive.
Pressure: 20 grms. min.

COIL: Resistance: .016 to 34,500 max.
Power: DC, 9 watts. } at nominal voltage.
AC, 18.4 Volt Amps. }
Duty: Intermittant.
Insulation: Cellulose acetate wrap; varnish impregnated (open).

MOUNTINGS: Two 7/32" dia. holes on 2 5/8" center.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

Potter & Brumfield, inc.

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SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Ky. and Laconia, N.H.

Mail the coupon below for further engineering data on P&B's new PC Series relays *plus* new compact catalog of standard type relays. If you need answers to a specific application problem, write in detail.

Potter & Brumfield, Inc., Princeton, Indiana
Attn: T. B. White, Brig. Gen. USMC (Ret.)
Special Projects Engineer

Please send me complete data on the new PC Series relays, plus the new compact catalog of P&B standard relays.

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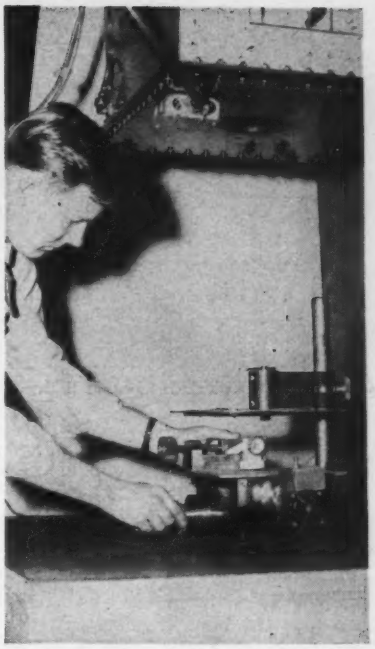
See our catalog in Sweet's Product Design File



Waveguide is positioned on Vernier table under slot in lead sheet

for quality control and design purposes.

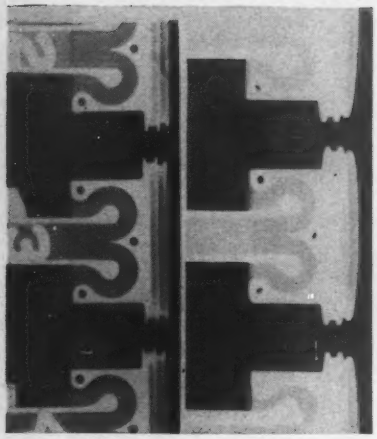
Any feature having a difference in thickness of 5 percent or more between two points may be measured. Accuracies of 0.0005 inch are obtained on parts ½ inch high and 0.001 inch accuracy on parts 1 inch high.

Enlarged or overlapping images are prevented by masking all x-rays except those which can pass vertically through a slot in a lead sheet. The part to be measured is placed on film and swept under the defined beam. Dimensions are later measured from the film in an optical comparator.

The slotted ½ inch lead sheet, backed by Plexiglas for strength, is mounted on the arm of a Vernier table. A 10 rpm motor is coupled to the table's longitudinal screw so that the table travels at 1 inch per minute.

The component is mounted in a fixture on the table so that the direction to be measured traverses across the slot. If dimensions in other directions are desired, another picture must be taken as the slot filters only vertical x-rays perpendicular to the travel.

Components must be mounted exactly square to the x-rays. Verti-



Film strips show difference between ordinary x-rays and new method (left)

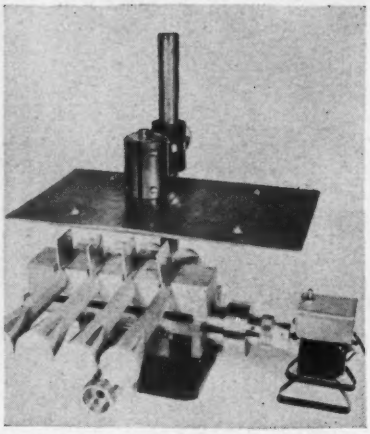


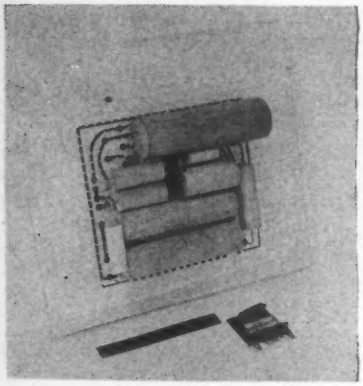
Table setup is shown here. Traversing motor is on skids so it slides with table

cal sides must be exactly parallel to the line of a plumb-bob hung from the focal point of the x-ray tube to the slot.

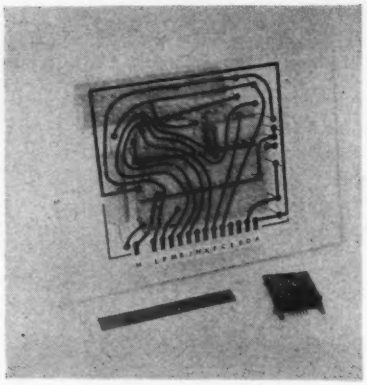
The smaller the slot, the better. However, decreasing slot size requires increases in voltage and reduced travel speed. The 1 inch per minute travel speed is satisfactory for $\frac{3}{16}$ inch aluminum using a 0.020 inch slot with 125 kvp and 10 ma source placed 30 inches from Ansco A film. Greater thicknesses may be measured by several passes. For example, three passes distinguish a change from $\frac{3}{4}$ inch to $\frac{7}{8}$ inch.

Models Simplify Circuit Planning

By **W. W. STALEY** Arm Air Division, Westinghouse Electric Corp, Baltimore, Md



Components assembled on layout board give 3-D picture of completed unit



Board transparency makes taping the wiring pattern a simple procedure

THREE-DIMENSIONAL models of components, arranged on a transparent layout board, permit rapid conversion of hand-wired plug-in units to printed wiring.

The method reduces time required for conventional layout methods, time spent in sketching and resketching, arranging templates and drafting side views. In the conversion pictured, the packaging engineers had so minimized waste space that components had to be stacked very closely in order to stay within given physical boundaries.

The layout board is made of $\frac{3}{8}$ inch Plexiglas with an overall size of 12 by 14 inches. Fixed grid spacing is accomplished by drilling 0.070 inch holes with a spacing of 0.4 inch, a total of 589 holes. Hole

ENGINEERS

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Increased activity in the design and production of system electronics has created openings for engineers in the following areas:

ELECTRONIC AND AIR DATA SYSTEMS Required are men of project engineering capabilities. Also required are development and design engineers with specialized experience in servo-mechanisms, circuit and analog computer design utilizing vacuum tubes, transistors, and magnetic amplifiers.

SERVO-MECHANISMS AND ELECTRO-MAGNETICS Complete working knowledge of electro-magnetic theory and familiarity with materials and methods employed in the design of magnetic amplifiers is required.

FLIGHT INSTRUMENTS AND TRANSDUCER DEVELOPMENT Requires engineers capable of analyzing performance during preliminary design and able to prepare proposals and reports.

FLIGHT INSTRUMENTS DESIGN Requires engineers skilled with the drafting and design of light mechanisms for production in which low friction, freedom from vibration effects and compensation of thermo expansion are important.

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Cooling for electronic reliability...by AiResearch

SPECIFICATIONS

COOLING CAPACITY	Full 1.5 kw at 50,000 ft. ambient pressure altitude and inlet conditions as follows:
AMBIENT AIR	TEMPERATURE: 10°C. PRESSURE: 1.7 psia FLOW: 3.6 lb/min
CONTAINER GAS	TEMPERATURE: 85°C. PRESSURE: 20 psia FLOW: 9.8 lb/min

The AiResearch unit shown above solves another critical electronic cooling problem in the following manner:

The larger fan, at top left of unit, draws cooling ambient air through the heat exchanger. Simultaneously, the smaller fan, at bottom center of unit, circulates dense, non-toxic sulfur hexafluoride (SF_6) through the heat exchanger and over the electronic equipment. The cooled gas maintains the sealed electronic equipment at the desired temperature.

The 20 by 24 inch honeycomb mounting base for the cooling components is designed by AiResearch to form an integral part of the pressurized electronic equipment container.

This cooling package, incorporating standard, proved components, was developed by AiResearch in minimum time. It and other air or liquid-cooled units for similar purposes are based on almost 20 years of experience in the development of cooling systems for aircraft, missile and nuclear applications.

Send us details of your problems or contact the nearest Airsupply or Aero Engineering office for further information.

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

How
SMALL
do you want
your
Shift Registers?

MINIBIT
ACTUAL SIZE
• low power consumption
• highly reliable
• only 1.8 cubic inch per binary digit
• Engineered for printed circuits
• Designed for severe service conditions
See MINIBIT™ shift registers and other Epsco Components at IRE Booth 2120

Chances are Epsco's new line of "MINIBIT" miniaturized shift registers can meet your specifications to a T. Operating rates up to 500 KC and above . . . fully encapsulated . . . substantial savings in weight and space.

Whatever your requirements relating to buffer storage, pulse distribution or other pulse, digital and logic functions, we would like to talk to you about them. Epsco designs and manufactures a wide variety of transistorized, transistor-driven and tube-driven shift registers and magnetic logic elements, featuring high reliability, low-power consumption and compactness.

Custom engineering-production of electronic components (shift registers, magnetic logic elements, delay lines, special pulse transformers, plug-in logic elements, etc.) is our specialty. Write for Technical Bulletin #58-1.
Epsco Components, Dept. R-308, 108 Cummington St., Boston 15, Mass.

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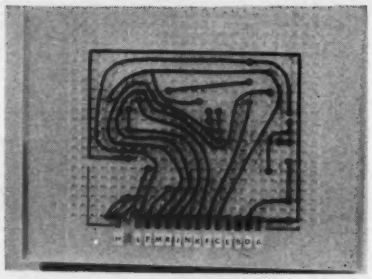
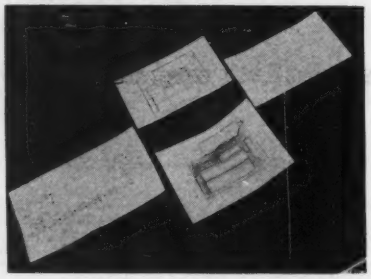
Epsco COMPONENTS

CIRCLE 178 READERS SERVICE CARD



Photograph of taped layout could serve as negative for printing the circuit



Circuit layout prepared from sketches lacks clarity of models

spacing tolerance of 0.005 inch permits using the board for final conductor layout.

Component models are cut from hardwood doweling. Many components fit standard dowel sizes and near sizes may be substituted for odd component sizes. Brass welding rod 0.064 inch in diameter, which is easily cut and shaped by hand, is inserted into drilled 0.070 inch holes to represent the component leads.

Successful building and testing of laboratory models justifies confidence in the layout method. Actual units built required no relayout. Cost is negligible compared with savings rendered.

Assembly drawings could be replaced by a photograph of the final breadboard layout. The negative used for printing the circuit could be made from the tape layout on the back of the layout board.

New Kit Modifies Wire Wound Pots

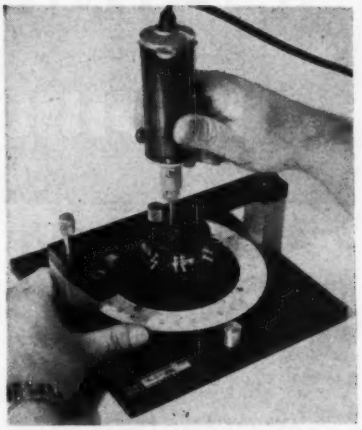
POTENTIOMETERS may be modified or made up from basic units with a new kit, supplied by Micro-Lectric Division, Micro Machine Works, Inc., Roosevelt, N. Y., for use on precision wire wound pots.

The kit enables pots to be prepared to specifications from basic units available without taps or buss bars, permitting quick field replacements. Pots may also be modified during experimental work or to satisfy engineering changes.

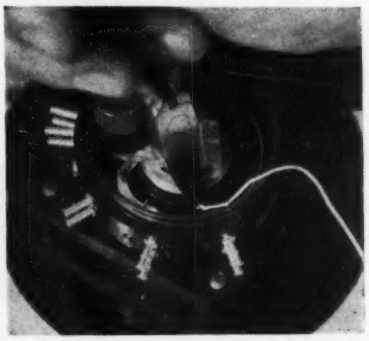
The kit contains 100 tap assemblies, 25 silver buss bar rings, buss bar cutting fixture, buss bar forming die, drill jig, electric drill and 20 other parts needed for precision drilling of tap holes and installation of taps and buss bars. A case is provided.

Potentiometer is first placed in nest of drill jig and locked in place. Tap drilling position is located by protractor in jig base. Taps may be spaced within 1.5 degrees. The tap hole is drilled through a bushing.

One-piece precious metal taps with color-coded leads are inserted in the holes. The taps are depressed with a plastic pick so that their spring pressure holds them against



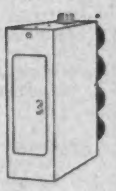
Tap hole is drilled through bushing after pot is positioned in drill jig

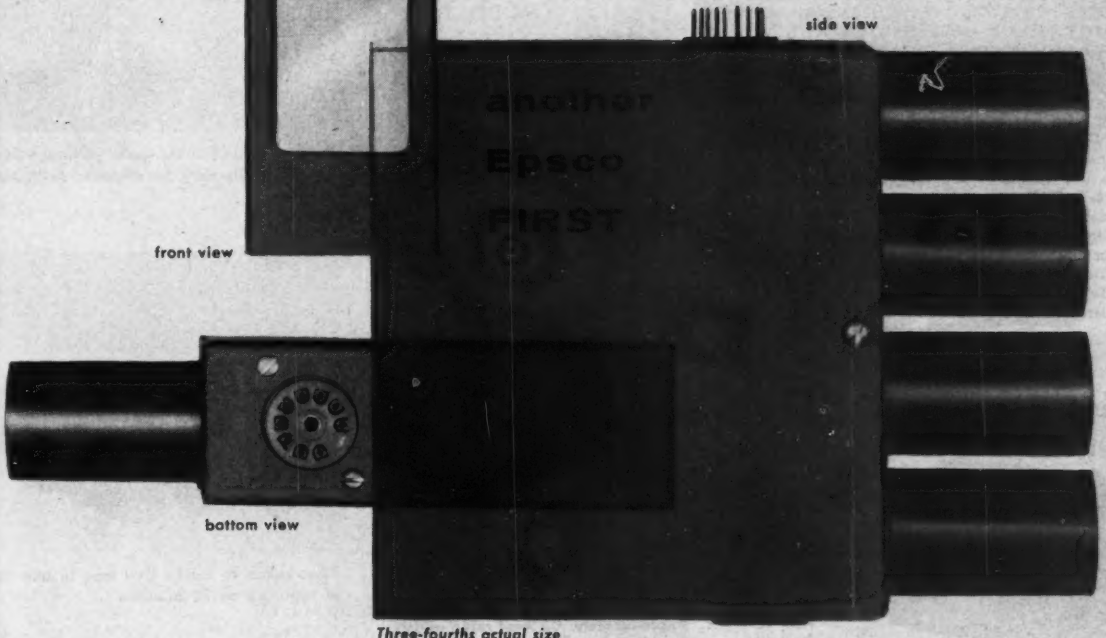


Tap is inserted in drilled hole

now TRANSISTORIZED

decade counter





Three-fourths actual size

Once again Epsco Components scores a first . . . a completely transistorized 150KC decimal counter unit that offers unique advantages in compactness, light weight, and low power input requirements. Read-out is indicated in highly legible ⅜" numerals on a translucent panel. The mating of inherent transistor stability with reliable circuit design guarantees dependability for an indefinite period. Epsco's Model CT-101 features plug-in, encapsulated flip-flops, and is fitted with a 9-pin miniature plug as well as a 9-pin socket providing outputs for remote indication purposes.

Custom engineering-production of electronic components (shift registers, magnetic logic elements, delay lines, special pulse transformers, plug-in logic elements, etc.) is our specialty. Write for technical bulletin. *See Decade Counter and other Epsco Components at IRE Booth 2120.* **Epsco Components, Dept. R-38 108 Cummington St., Boston 15, Mass.**

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A PRECISION PHASE MEASURING INSTRUMENT

MODEL 200 A

PRICE
$349.50

• HIGH ACCURACY • MEASURES FROM 0 TO 360 DEGREES • READINGS NOT AFFECTED BY NOISE AND HARMONICS • PHASE SHIFTS OF THE ORDER OF .01° CAN BE MEASURED EMPLOYING SPECIAL CIRCUIT TECHNIQUES • MEASURES IN-PHASE AND QUADRATURE COMPONENTS SEPARATELY

SPECIFICATIONS

Accuracy	±2 degrees
Noise and Harmonic Rejection	40 DB down
Sensitivity	6 millivolts full scale
Frequency Range	20 to 20,000 C.P.S.
Power Supply	105-125 Volts, 60 C.P.S.,
Dimensions	9 x 15 x 8 inches

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FOR LABORATORY AND PRODUCTION IMPEDANCE TESTING

• TESTS RESISTORS, CONDENSERS, INDUCTORS • PERCENTAGE DEVIATION FROM STANDARD READ ON LARGE METER • RAPID RESPONSE — NO BUTTONS TO PUSH • HIGH ACCURACY AND STABILITY • SELF CALIBRATING — REQUIRES NO RECALIBRATION WHEN CHANGING RANGES

MODEL 1010

PRICE
$299.00

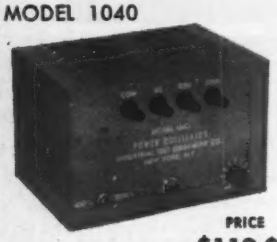
SPECIFICATIONS

Bridge Supply Volts	2 volts
Component Voltage At Balance	1 volt
Frequency	Either 1,000 C.P.S., or 10,000 C.P.S.
Full Scale Ranges	±5%, ±10%, ±20%
Component Test Ranges:	
Resistance	5 ohms - 5 megohms
Capacitance	50 mmf - 20 mfd
Inductance	100 microhenry - 80 henries
Power Supply	105 - 125 volts, 60 C.P.S.
Dimensions	9 x 15 x 8 inches

POWER OSCILLATORS

A COMPACT PRECISION OSCILLATOR PROVIDING 3 WATTS OUTPUT

MODEL 1040



PRICE
$119.00

• EXCELLENT ACCURACY AND STABILITY • TRANSFORMER ISOLATED OUTPUT • 3 OUTPUT IMPEDANCES • LOW INTERNAL IMPEDANCE • OUTPUT VARIABLE UP TO 120 VOLTS

SPECIFICATIONS

Frequencies	400 or 1000 C.P.S. by selector switch (other frequencies on request)
Distortion	Less than 1%
Hum Level	Approximately .05% of rated output
Output Power	3 watts into matched resistive load
Power Supply	115 volts, 60 C.P.S., 40 watts
Dimensions	5-11/16 x 9 x 6⅛ inches

Manufacturers of:

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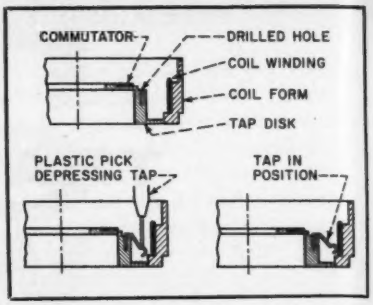
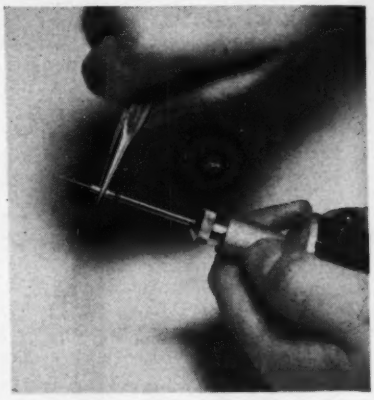
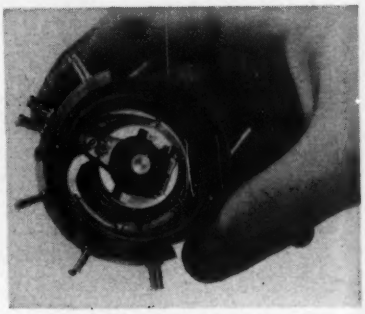


Method of springing tap into position against pot coil



Drill extension holds drills without solder so that drills may be changed with pair of pliers



Time taken to install five taps in this pot is reported as 30 minutes

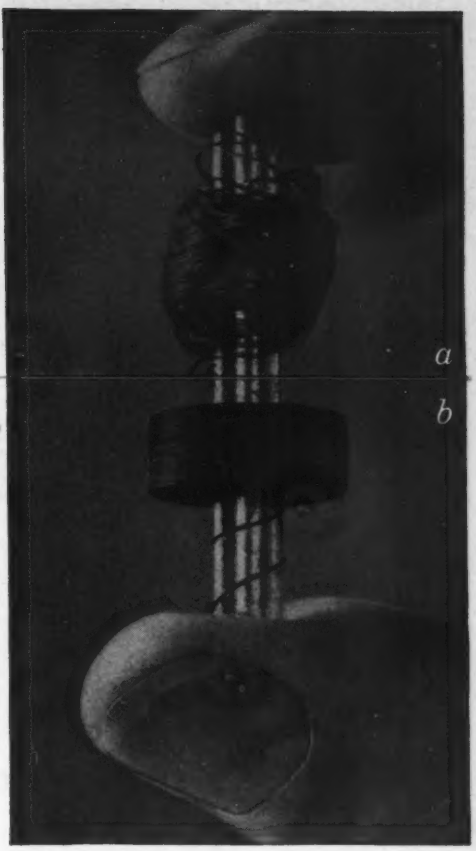
the coil winding.

The miniature drill extension supplied is made by Ritmar Corp., Huntington, N. Y. Its concentricity is reportedly more accurate than soldered drills. Turning a threaded locking sleeve clamps the drill in an internal holding slot. Drills are changed by loosening the sleeve with pliers. The extension has a uniform outside diameter of ¼ inch, which fits bushings in drill jig.

If you have this problem, investigate

GRIP-EZE®

—an example of Phelps Dodge's realistic approach to Magnet Wire research



THE PROBLEM: **To develop a solderable film-coated wire without fabric for winding universal lattice-wound coils without adhesive application.**

THE SOLUTION: **Phelps Dodge Grip-eze—a solderable film wire with controlled surface friction for lattice-wound coils that provides mechanical gripping between turns and keeps wire in place.**

EXAMPLE: **Coils wound with (a) conventional film wire; (b) Grip-eze. Note clean pattern of Grip-eze as compared to fall-down of conventional film wire.**

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

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Unveil New P-C Components

Feature Stable Mounting

PRINTED circuits are part and parcel of the ever growing trend toward subminiaturization. Components for these circuits must be made to meet requirements of size and mounting stability.

American-Monarch Corp., 81 N.E. Lowry Ave., Minneapolis, Minn., (400), announces a tiny spdt relay designed specifically for direct application to p-c boards. Good mounting stability is maintained by wide spacing of the silver plated pins. Palladium inlay contacts assure positive contacting of dry circuit switching.

Now in production at **Cambridge Thermionic Corp.**, 445 Concord Ave., Cambridge 38, Mass., (401), are ceramic coil forms available with four terminals for mounting on p-c boards. Suitable for high temperature conditions and missiles, they are also equipped with the Cambion Perma-Torq locking device for set tuning. Terminals are electro solder plated ready for dip soldering.

Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill., (402), introduces microminiature glass Zener diodes for circuits where mounting space is at a minimum. They are designed for clipping, limiting, regulating and similar applications.

Connectors with bellows action contacts have been developed by **DeJur Amsco Corp.**, 45-01 Northern Blvd., L.I.C. 1, N. Y., (403). It is possible for the connector to accept p-c boards that can vary in thickness from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. Self-alignment of the bellows contacts allows for any residual warpage of the p-c board.

Waters Mfg. Inc., Boston Post Road, Wayland, Mass., (404), has available a Dialpot subminiature potentiometer having a diameter of $\frac{1}{2}$ in. and an overall length of $\frac{1}{2}$ in. (including calibrated dial, excluding terminals). Terminals are located on a standard 0.1 in. grid as used in printed circuitry.

For more information use READER SERVICE CARD

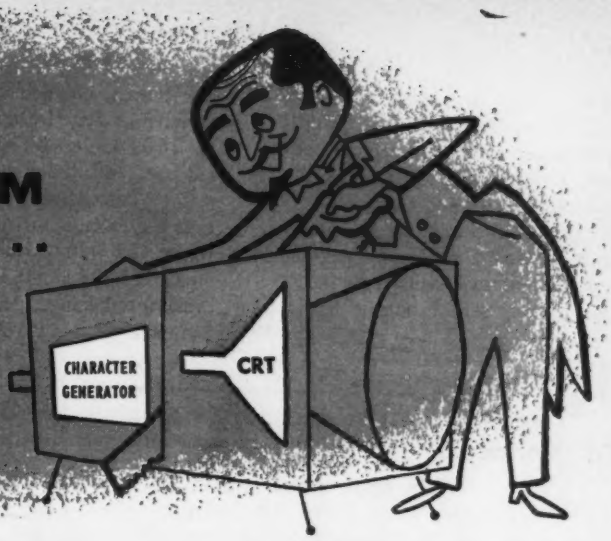
B-Power Supply compact unit

SORENSEN & CO., INC., Richards Ave., South Norwalk, Conn. Model 300B wide-range B-power supply, a new B-Nobatron, utilizes printed circuits for lightness, compactness and reduced cost. It features parallel or series operation, external sensing, excellent regulation and stability, and low ripple. It provides a regulated 0-300 v d-c output and unregulated 6.3 or 12.6 v a-c filament outputs, and is available in single or dual units in a cabinet or for rack mounting.

The front panel of the 300-B has a 4-position power and meter

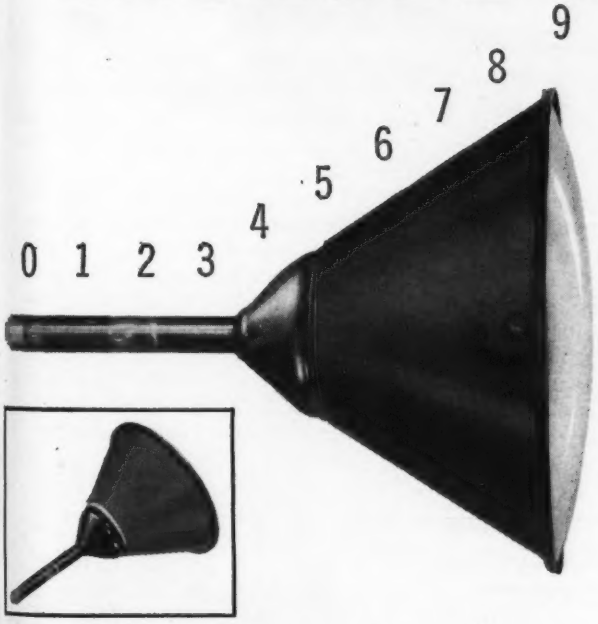
Separate

THE EXPENSE FROM THE EXPENDABLE...



Investigate

CHARACTER DISPLAY VIA CATHODE-RAY TUBES



No longer is it necessary to put all your eggs in one basket when it comes to character read-out displays. Now you can do it better, and more economically, with Du Mont cathode-ray display tubes in one of several commonly-known systems. Such a system permits the replacement of the display unit *alone*, eliminating the very expensive replacement of integrated tube and generator, and at the same time, provides these outstanding PLUS FEATURES...

- **Bright, flickerless display** — permits read-outs under high ambient light conditions. No annoying, low-frequency flicker.
- **Space-saving** — greatest screen diameter-to-length ratio. Du Mont display tubes are available in 5, 12, 15, and 19-inch screen diameters.
- **Versatility**—variable size characters, positioned anywhere on screen.
- **Low replacement cost** — the generator is completely divorced from the CRT. For replacement, only the cost of a moderately-priced tube.
- **Speed** — electrostatically-formed and electromagnetically-positioned characters for greatest speed and accuracy.

If you use, or are considering the use of character display read-out—investigate display by cathode-ray tubes
— WRITE FOR COMPLETE DETAILS...

DU MONT®

INDUSTRIAL TUBE SALES, ALLEN B. DU MONT LABORATORIES, INC., 2 MAIN AVE., PASSAIC, N. J.
BE SURE TO VISIT DU MONT AT THE IRE SHOW IN NEW YORK. BOOTHS 3705, 3707

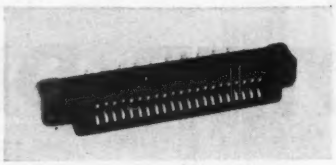
switch with OFF, DC-OFF, VOLTS and MA settings; a voltmeter-milliammeter; an output voltage control; d-c and a-c output terminals; and external sensing terminals. At the rear of the unit are a 3-prong input line cord, a plug for parallel operation of two units, two fuses, and another set of output terminals.

Electrical characteristics include positive or negative output voltage of 0-300 v d-c, 0-150 ma output current, regulation accuracy of ± 0.15 percent or ± 0.3 v, whichever is greater, 5 mv-rms maximum ripple, 2.0 ohms internal impedance, 105-125 v a-c 50/60 or 400 cycle input range, and two 6.3-v 5-ampere filament voltage circuits which may be connected in series or parallel.

A single 300-B in a cabinet is 10¾ in. wide by 9¼ in. high by 12⅛ in. deep. A dual cabinet unit is 19 in. wide. The single or dual rack mounted types are 8¾ in. high. Weight of a single cabinet unit is 29 lb. **Circle 405 on Reader Service Card.**

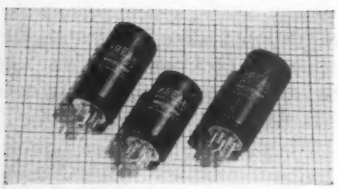
P-C Connector
in four small sizes

ELCO CORP., M. St., below Erie Ave., Philadelphia 24, Pa. The 6003 series answers the need for a microminiature printed circuit connector with 0.078 in. spacing between printed circuit contact lines. It comes in four sizes with 14, 21, 31 and 37 contacts, which are made of beryllium copper, silver plated or gold plated. The



connector is designed to receive a ⅛ in. board with commercial tolerances of ± 0.0075 in. Design of the contact guarantees low contact resistance at all board thicknesses with no change after a thousand insertions and withdrawals. Castings are made of glass-filled diallyl phthallate. They have very close tolerances and are stable under wide ranges of temperature and humidity. The contact tails have wire holes for soldering wires to it. A polarizing tab can be inserted at any contact location. **Circle 406 on Reader Service Card.**

Magnetic Amplifier
low-level unit



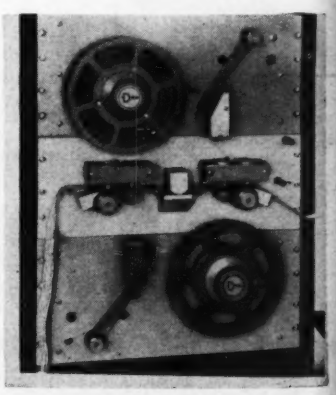
AIRPAX PRODUCTS CO., Middle River, Baltimore 20, Md. Preac amplifiers are a new line of high sensitivity magnetic amplifiers. Specifically designed as preamplifiers for such data sensing devices as thermocouples, strain gages, bolometers, and electrometers, these low-level units produce full output with inputs of fractions of microwatts. Three standard types provide power gains rated to be greater than 54 db, 60 db, or 51 db. As little as 0.0026 μw input produces full output of 4 v into a 5,000-ohm load. Null drift does not exceed 0.1 μa under this condition.

Preac amplifiers are rated for operation from 400 ± 40 cps power lines at 115 ± 11 rms volts. They draw less than 2w of power, which, for lowest null, should be free of even harmonics. These amplifiers accept d-c polarity reversible input signals and deliver unfiltered d-c polarity reversible outputs. **Circle 407 on Reader Service Card.**

Paper Tape Reader
strip and reel feed

DIGITRONICS CORP., Albertson Ave., Albertson, L. I., N. Y. The new compact Dykor paper tape reader provides all the advantages of strip and reel feed by combining both in one unit. Manual access time is reduced appreciably because short programs require no splicing, no tape switch is required to locate a desired block, and program filing is simplified. It stops within one character at a reading rate of 600 characters per sec and within two characters at 750 characters per sec because of a special braking system.

The tape is set in motion when a solenoid operates a pressure roller to squeeze the tape against a continuously-rotating capstan in a wringer-like action. Two oppositely-rotating capstans allow the tape to be driven in either direction, with



CIRCLE 154 READERS SERVICE CARD→

There is No Substitute for Reliability—

NEW *miniaturized* "MAG MOD"

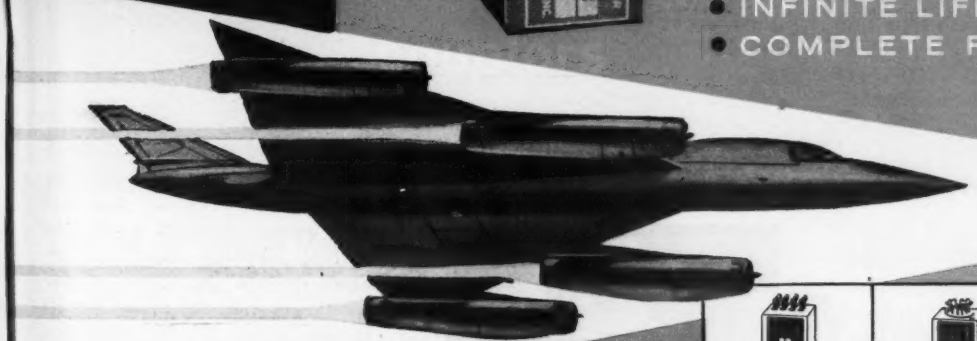
Magnetic Modulators

All Magnetic Modulators strictly conform to MIL-T-27A. Some typical circuit applications for Magnetic Modulators are algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gains, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.

Especially Engineered for Printed Circuit Wafer Designed Structures and Circuit Assemblies Featuring:

Actual Size

- FASTER RESPONSE TIME
- NEGLIGIBLE HYSTERESIS
- EXTREME STABILITY
  (Ambient Temp. Range from −65°C to +135°C)
- COMPACT SIZE
- LIGHTWEIGHT
- INFINITE LIFE
- COMPLETE RELIABILITY



Miniaturization of the new Magnetic Modulator makes it possible to incorporate this component into wafer type structures and transistorized printed circuit assemblies without sacrificing ruggedness or reliability.

CONSULT GENERAL MAGNETICS on magnetic amplifier components for automatic flight, fire control, analog computers, guided missiles, nuclear applications, antennas, gun turrets, commercial power amplifiers and complete control systems. Call or write for Catalog B on miniature and standard components.

TYPE NUMBER	Magnetic Input Modulator	Magnetic Input Modulator	Magnetic Thermocouple Converter
	IMM-436-2	IMM-436-3	MTC-435-2
Excitations Frequency—Carrier	400 cps	400 cps	400 cps
Signal Winding DC Resistance	1000 ohms ±15% each signal winding	1000 ohms ±15% each signal winding	10 ohms ±15%
AC Excitation Volts	5.5 V. @ 400 cps	2.5 V. @ 400 cps	6 V. RMS
Input DC Signal Range	0 to ±100 μa.	0 to ±80 μa.	0 to ±10 mv.
AC Output Range	0 to 2.2V. @ 400 cps (sine wave)	0 to 1.5V. @ 400 cps (sine wave)	0 to 2.7V. @ 400 cps (sine wave)
Overall Dimensions (Inches)	27/32x27/32x1 5/16	27/32x27/32x1 3/16	1 1/4x7/8x5/8
Null Amplitude (Noise Level)	20 mv. RMS	15 mv. RMS max.	25 mv. RMS max.
Output Impedance	7000 ohms	7000 ohms	10,000 ohms
Null Drift (In terms of input signal) −65°C to +100°C	±0.5 μa. max.	±0.5 μa. max.	±0.1 mv. max.
Hysteresis — % of maximum input signal	0.5% maximum	0.5% maximum	0.5% maximum
Type of Mounting	Male Stud	Female Insert	Male Stud
Maximum % Distortion in Output	25%	15 %	20%
Weight Ounces	1.3 oz.	1.2 oz.	1.5 oz.

GENERAL MAGNETICS • INC.
135 BLOOMFIELD AVE., BLOOMFIELD, NEW JERSEY

GM INC

starting time less than 5 millisec. Thus by using the reverse feed control, programs requiring repeat feedings proceed more rapidly. To stop tape motion, the driving solenoid is released, and the stop solenoids are actuated.

All standard 5, 6, 7 or 8 level tapes (plus sprocket hole) are handled and ½ in., ⅞ in. or 1 in. wide tape can be used interchangeably. Safeguards provided are end-of-tape sensing and tape-break sensing, with an interlock preventing operation if the tape is improperly threaded. Photoelectric sensing makes fast reading possible.

Another feature is complete remote control including forward, reverse, stop and speed change. **Circle 408 on Reader Service Card.**

Recording Test Unit

uses semiconductors

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. A complete read-write test system for magnetic tape or drum memories, measuring 11 in. high, by 11 in. wide, by 9 in. deep, is available. Individual units are entirely transistorized, and printed circuit techniques are utilized throughout, resulting in excellent reliability, small size and low power requirements.

The modular units pictured are, from top to bottom, a 10 bit shift register for parallel-to-serial conversion of incoming data or serial-to-parallel conversion of outgoing data, a 10 channel NRZ write-amplifier, a 10 channel NRZ read-amplifier, and a regulated power supply.

These units are compatible with all other units in the line of the company's transistorized pulse programming equipment, and may be combined with over 40 functional units for digital data processing and data storage. **Circle 409 on Reader Service Card.**

Zener Diodes

sixty-four types available

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., introduces a complete line of silicon Zener voltage regulator and reference diodes comprised of a series of types in each of seven styles. The listing of 64 types includes: miniature types rated at 500 mw, standard top-hat style with pigtail leads rated at 1 w, 3.5 and 10 w types featuring stud construction, double-anode types rated at 350 mw, 5 w multiple junction h-v types and the 1N430,

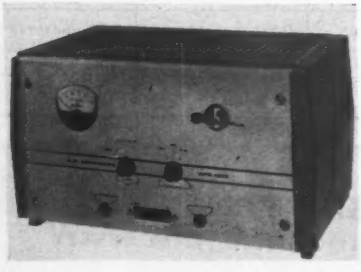
1N430A and 1N430B reference element types.

All diodes in this group are designed and manufactured to meet the most rigid military specifications. High temperature operation (− 65 C to + 150 C) and high load current capacity result from a most advanced thermal design. Sharp reverse breakdown characteristics provide the means for obtaining stable voltage regulation over a wide operating range. Mechanical features such as all-welded construction and hermetic sealing assure long term reliability.

As a technical service to the design engineer, an x-y plot of the reverse breakdown characteristics is supplied with each diode. **Circle 410 on Reader Service Card.**

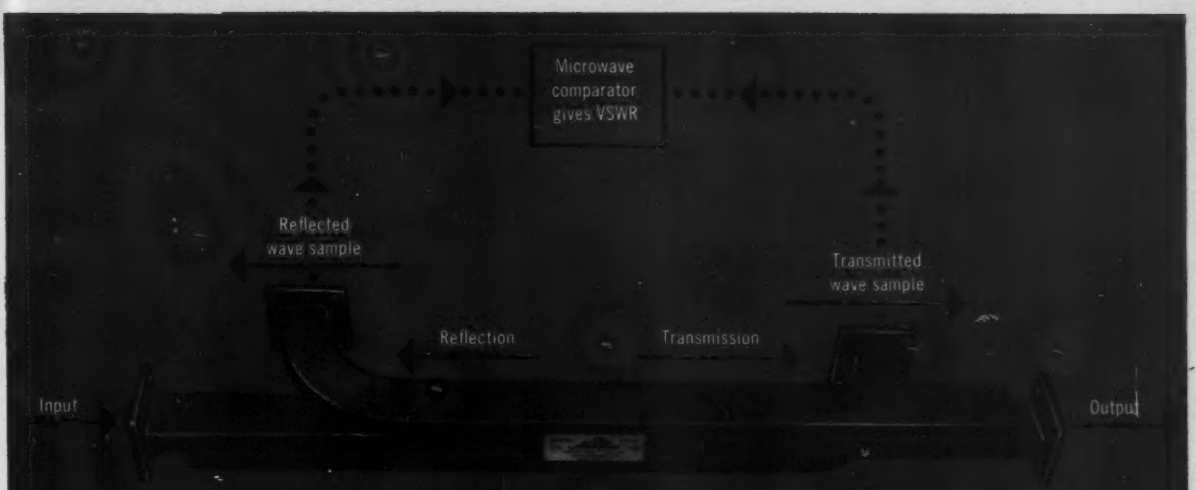
Voltage Regulator

all-purpose unit



SORENSEN & CO., INC., Richards Ave., South Norwalk, Conn. Model APR1010 is a tubeless all-purpose a-c voltage regulator with wide flexibility of operation. It can be used to regulate average and peak voltages as well as rms, independent of input waveform. By simply turning a switch, the regulator output can be matched to the special requirements of the load.

It provides five different sensing arrangements: internal (normal a-c regulation), external a-c (any a-c voltage), remote (115 v a-c at a remote location) constant current, and d-c. Terminals are provided at the rear of the unit to enable the 0.1 percent a-c load regulation accuracy to be held at a remotely located load. This feature also enables load voltages other than



New high-directivity bi-directional couplers

Frequency Range (kmc)	2.60-3.95	3.95-6.00	8.2-12.4
Waveguide Type (AN)	RG-48/U	RG-49/U	RG-52/U
Waveguide Size	3" x 1½"	2" x 1"	1" x ½"
Waveguide Flanges	UG-214/U	UG-149A/U	UG-39/U
Weight	18 lbs	9.1 lbs	2 lbs
Dimensions	48⅞" x 9½₃₂" x 8⅜₁₆"	31¹¹⁄₁₆" x 7¹¹⁄₃₂" x 5½"	18¾₄" x 3⅞" x 2⅝"

Featuring two opposing couplers in a single waveguide unit, Sperry's new Microline® Bi-Directional Couplers provide complete coverage of waveguide frequency ranges. They are designed for VSWR measurements and continuous monitoring in combination with ratiometer, comparator, barretter mounts or other detectors.

Three models cover S, C and X bands, with uniform coupling (10db ± 0.5) and high directivity (40db) for accurate coupling calibration. If you'd like more information on the Sperry couplers shown here, write our Microwave Electronics Division for "latest data on directional couplers."

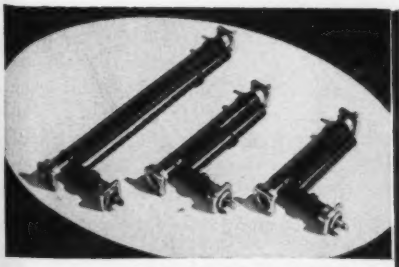
MICROWAVE ELECTRONICS DIVISION

SPERRY GYROSCOPE COMPANY
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

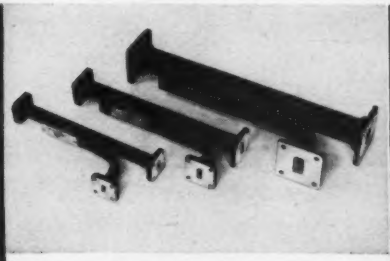
BROOKLYN • CLEVELAND • NEW ORLEANS • LOS ANGELES • SEATTLE • SAN FRANCISCO. IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

Visit our booths 1416-1422 at 1958 Radio Engineering Show, March 24-27.



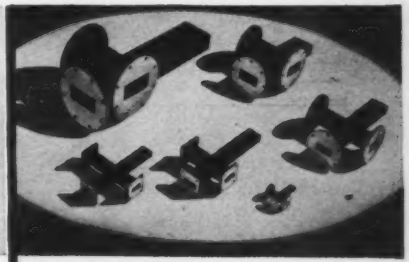
COAXIAL DIRECTIONAL COUPLERS

Used to monitor system power output and to provide local-oscillator or test-signal injection into receivers. Feature very low variation in coupling over 2-to-1 frequency range. Directivity is kept high by frequency-sensitive compensation.



BRANCH-GUIDE DIRECTIONAL COUPLERS

Serve as decoupling and isolating waveguide sections, with negligible effect on other system components. Offer high directivity and uniform coupling over full frequency range. Can be permanently installed in system transmission line.



CROSS-GUIDE DIRECTIONAL COUPLERS

Designed to operate as space-saving one-way power monitors in waveguide transmission lines. For measuring power, VSWR and receiver sensitivity. Directivity is high and coupling is uniform over 40% frequency range.

See These Products At The 1958 I.R.E. Convention Booth 2705

ERA's TRANSISTORIZED

HIGH CURRENT

REGULATED POWER SUPPLIES

Ratings up to 12 Amps!

- Ideal for Battery Substitution
- Computers
- Life Testing Racks
- Transistor Biasing
- Motor and Relay Control
- Television
- All High Current Laboratory or
- Industrial Applications

The high current transistorized power supplies first introduced by ERA has important features not available in later imitations:

- Continuously Variable Output
- Fast Transient Response
- Low Output Ripple
- Positive, Negative, Zero percent Regulation Control
- Line Frequency Insensitive
- Remote Sensing
- Constant Current Overload Protection
- Positive or Negative Outputs Ungrounded
- Terminals on Front and Rear
- Hinged Panel for full Accessibility
- High Efficiency
- Low Heat Dissipation
- Compact, Light weight
- Instant Warm-up Time
- Moderately Priced

TYPICAL STOCK MODELS

Model Number	Voltage VDC	Current Amps.	Output DC R (ohms)	Price FOB Factory
TR32-4	6-32	0-4	0.01*	$375.00
TR32-8	6-32	0-8	0.005*	$410.00
TR32-12	6-32	0-12	0.002*	$495.00
TR150-1	20-150	0-1.0	0.1	$425.00
TR300-1	170-300	0-1.0	0.2	$605.00

*Typical Values, adjustable to zero or negative.

Models listed are stock units. Other designs available to customer specifications. Write for quotation.

Pioneers in Semi-Conductor and Transistorized Products.

First Miniaturized Power Packs.
First Transistorized Power Supplies.
First Automatic Transistor Test Equipment.
First Dual Output Tubeless Supplies.
First Packaged Transistor Circuits.
First Transistor Application Power Supplies.
First Constant Current Generators.
First High Current Semi-Conductor Regulated Supplies.
First "E" Core Transistorized Converters/Inverters.
First High Power Semi-Conductor Frequency Changers.

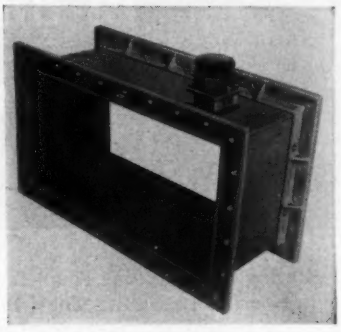
Manufactured at ERA's New and Larger Facilities

Electronic Research Associates, Inc.
67 Factory Place, Cedar Grove, N. J.
CEnter 9-3000

110-120 v to be accurately regulated by means of an external matching transformer, without disturbing the regulator wiring.

Other terminals at the rear of the APR1010 allow it to be used as a d-c controller. Full-wave capacity-input d-c power supplies can be regulated to an accuracy of 0.1 percent.

The APR1010 features 3 percent maximum harmonic distortion, 0.2 sec recovery with line changes and 0.1 sec recovery with load changes; ± 0.1 percent regulation accuracy with line or load changes; rapid starting; 0.04 percent drift in 24 hours and 0.1 percent drift in 1,000 hours. **Circle 411 on Reader Service Card.**



Waveguide RSWI small and compact

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn, N. Y. The new waveguide rotary standing wave indicator greatly simplifies the measurement of vswr, reflection coefficient angle, hence impedance, in the low frequency range.

Operating by means of a probe rotating in the plane of circular polarization of a waveguide, the waveguide RSWI provides a nonambiguous read-out of the sign of reactive components. Small, compact and lightweight with an insertion length of only 10 in., it eliminates the need for bulky slotted sections or reflectometers in the large waveguide sizes. It is available in a wide selection of waveguide sizes from WR-650 to WR-4200. If desired, the rotating probe can be motor driven for remote operation and to provide an

PROBLEM:

WHAT IS THE SQUARE ROOT OF YOUR DESIGN PROBLEM?

ANSWER:

$$\sqrt{BP + I \times E^n}$$

Not in books nor tables nor scales nor what-you-will can the above equation be found. For it is an equation based on what the men of Elco can create-in-the-mind, translate-into-actuality and prove-in-application. It is, in a word, the engineered answer to your specific problem; and can be found in such new and reliability-proven components as you have come to know and see pictured here.

The equation above represents Brain Power, plus Ingenuity times Experience to the Nth power, divided by infinity. And the result is the square root of many design problems and operating characteristics. Characteristically, too, you must certainly find the answer to yours among Elco's quality line. Come to know it well.

SEE US AT BOOTH 2234 IRE SHOW

SERIES 6003

Micro-miniature printed circuit connector with .078" spacing between contact lines. 14, 21, 31 or 37 contacts. Receives .062" thick board with ± .0075" tolerances. Write for Bulletin 103-A.

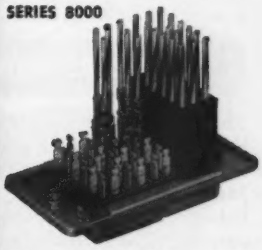
SERIES 5203

P. C. Varicon connector for plugging module boards perpendicularly into mother board. Designed for miniaturization with .100" contact spacing. For any number of contacts and any pattern. Write for Bulletin 108.

POWER TRANSISTOR SOCKETS

Designed to mate with Bendix Red Bank Power Transistor type #2N234, or other similar Power Transistors. Write for details.

SERIES 8000



Subminiature Varicon connector. 48 double-tier with honeycomb insulator shown. Other single and double-tier models, 8 to 80 contacts. Write for Bulletin 107.

ELCO-PACIFIC "B" SERIES

Cable or chassis type connector for light duty. Designed for audio, tv, geophysical and related use. 2, 3, 4, 5, 6 or 8 contacts. Current rating up to 30 amps; voltage, 2000 volts RMS. Female member has latch lock for fast coupling and guaranteed locking. Fully interchangeable with comparable units. Write for details.

IF IT'S NEW...IF IT'S NEWS

...IT'S FROM ELCO CORPORATION

"M" STREET BELOW ERIE, PHILADELPHIA 24, PA., CUmberland 9-5500

HOW BORG EQUIPMENT DIVISION CAN HELP YOU

Our business is helping to solve design and production problems in the use of components for the highly specialized electronics industry. Borg's background provides the experience necessary to design and produce various types of components for you . . .

MICROPOT* POTENTIOMETERS

Borg Micropots offer a wide range of high-precision, single-turn, multi-turn and trimming potentiometers.

**Registered trademark of The George W. Borg Corporation.*

MICRODIALS

Direct Reading Microdials and Concentric Scale Microdials.

INSTRUMENT MOTORS

Rugged, dependable Borg-Motors are designed for quality instrument applications.

AIRCRAFT INSTRUMENTS

Instruments for commercial and military aircraft.

FREQUENCY STANDARDS

To meet your requirements in Frequency Standards for military or industrial applications.

TEST EQUIPMENT FOR AUTOMATION

Invaluable experience with automatic testing equipment is yours when you call on Borg.

Save time and money when faced with design or production problems of electronic components. Call on Borg. Let us send you the name of your nearest Borg "Tech-Rep" and a copy of catalog BED-A90 today.

OTHER BORG DIVISIONS

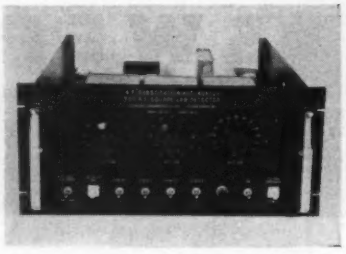
The George W. Borg Corporation is comprised of three divisions . . . the Borg Equipment Division at Janesville, Wisconsin, the Borg Fabrics Division at Delavan, Wisconsin which manufactures the fashionable "Borgana" fabric for coats and jackets and the Borg Products Division at Jefferson, Wisconsin, leading manufacturer of automotive clocks.

BORG *Built by Borg*
MOTORS
MICROPOTS
MICRODIALS

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

oscilloscopic presentation of vswr.

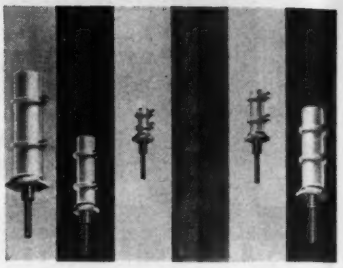
Other features are low residual vswr—less than 1.03; high accuracy—±2 deg maximum error in measurement of reflection coefficient angle with pure reactive load; high sensitivity—detects as little as 5 mw in the main waveguide; high-power application—permitted by adjustable coupling to detector; full frequency range—each waveguide band can be fully covered; adaptability for remote operation—because of the simple rotary motion involved. **Circle 412 on Reader Service Card.**



A-F Attenuator substitution unit

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. Model CF-1 a-f substitution attenuator is intended for measuring r-f power ratios in systems employing modulated r-f power sources and square-law r-f detectors. In such systems the audio voltage output from the detector is proportional to the r-f power input. It is necessary, therefore, to substitute audio attenuation equal to two times the change in r-f attenuation, all attenuation in decibels. This precision audio attenuator reads, in decibels, the change in r-f attenuation.

The a-f attenuator has a characteristic impedance of 2,000 ohms and is adjustable over a range of 104 db audio attenuation corresponding to 52 db r-f attenuation. A very linear cathode follower drives the attenuator, providing a high input impedance to the unit. The attenuator is terminated internally and designed for use with a moderately high impedance output indicator. **Circle 413 on Reader-Service Card.**



Ceramic Coil Forms 5 standard sizes

NATIONAL CO., INC., Malden 48, Mass. Designed for both military and commercial applications, a new line of ceramic soil firms is comprised of 5 standard sizes, each available with or without terminal collars; each terminal collar accepting up to four terminals per collar. All materials used are in accordance with MIL-specs. An internal pre-set torque spring positions and locks the adjusting cores thus keeping coils tuned as set, even under severe vibration and shock. **Circle 414 on Reader Service Card.**

SSB Tube new ratings

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y., has available new, ssb ratings on the type 6076 tube for new designs, equipment conversion, and for increasing present power output of linear amplifiers.

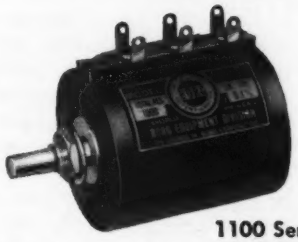
In the 2 to 5 kw envelopes power range, the 6076, a compact forced-

Why Gamble?

THERE'S A BORG MICROPOT® TO MEET YOUR EXACT SPECIFICATIONS!

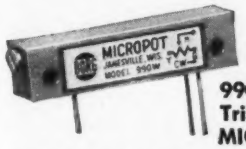
BORG MICROPOTS... the Ultimate in Multi-Turn Precision Potentiometers

Borg offers a complete line of high-precision, linear potentiometers called MICROPOTS. Precision is Borg's business . . . that's why MICROPOTS offer so many exclusive advantages. Superior design and production methods make Borg MICROPOTS available in any quantity. Write today for the name of your nearest Borg Jobber or "Tech-Rep."



1100 Series MICROPOTS

A precision MICROPOT that offers your products a price advantage in today's competitive markets. Lug or lead type terminals. Accurate . . . dependable . . . long lived.



990 Series Trimming MICROPOTS

Small in size, lightweight, rugged and dependable. Three types of terminals . . . printed circuit, solder lugs or insulated wire leads.

900 Series MICROPOTS

Standard ten-turn and three-turn models to fit most special design needs. Extremely accurate and dependable under adverse environmental conditions including severe vibration and shock.

205 Series MICROPOTS

A quality MICROPOT. Designed for both military and commercial applications. Proven in many different mobile and stationary types of electronic circuitry.

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THE GEORGE W. BORG CORPORATION
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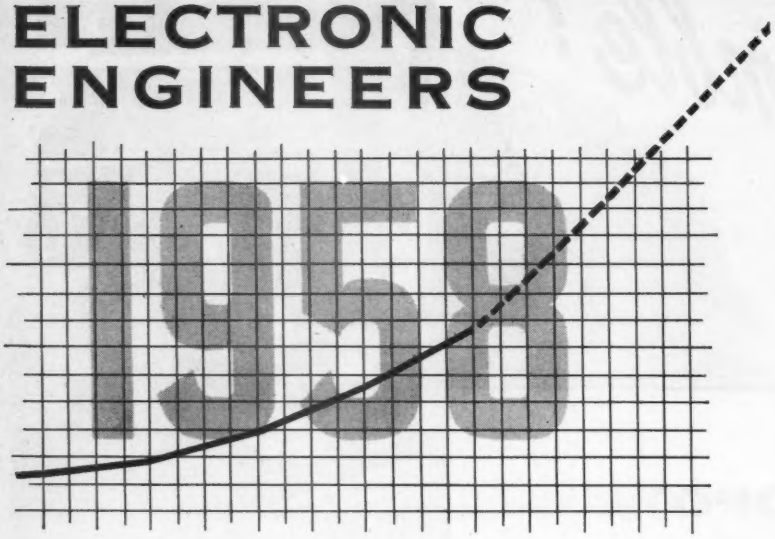
CIRCLE 134 READERS SERVICE CARD

ELECTRONIC ENGINEERS



1958 definitely promises to exceed the record-setting volume of our Electronics and Avionics Division last year. And we are not overly optimistic at all in our plans to double these figures during the next few years.

Emerson Electric, a leading medium-size manufacturer of missiles and electronic equipment, has a firmly outlined, long-range expansion program. Our plans require broadening our organizational structure immediately. This has opened unusual career opportunities with complex challenges.

We emphasize research, design and development, and maintain a strong balance in production work. Current projects include the B-58 fire control system, mortar locators, radar components and assemblies, servomechanisms, missiles and rockets, ground support equipment, microwave antennas, F-101 Voodoo subsystems, plus many other classified electronic devices for the supersonic era.

These positions require an E.E. degree plus 4-6 years' experience in electronics. Experience must include electronic design work in any of the following: servomechanisms, radar systems, analog or digital computers, fire control systems or ground support equipment. Missile guidance and/or infra-red experience will be helpful but is not essential.

Emerson Electric is a well-established dynamic organization with 900 engineers and 5000 employees. Salaries and benefits, including advanced education, are top level. Our suburban location is ideal in every way. All moving expenses are fully paid.

Be sure to send your complete resume NOW, including business experience, education and salary requirements, to A. L. Depke.

Your Future Is Our Business!

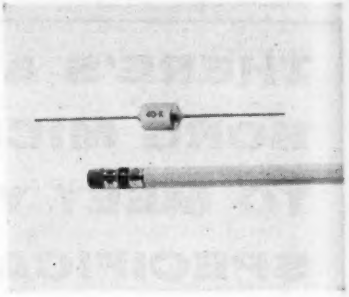
EMERSON ELECTRIC

Electronics and Avionics Division

8100 W. Florissant • St. Louis 21, Mo.

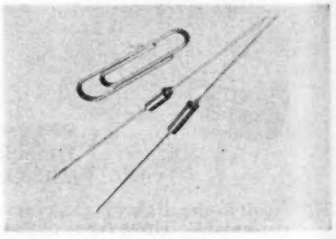
air cooled tetrode with a 3 kw dissipation rating, provides a range of powers hitherto only generated by paralleling a number of smaller tubes or under-rating larger ones.

Data are available on the use of the 6076 as a ssb amplifier that gives 38 db third and fifth order distortion products without r-f or envelope feedback in the 3 to 30 mc range. **Circle 415 on Reader Service Card.**



Silicon Rectifiers axial leads

SARKES TARZIAN, INC., 415 College Ave., Bloomington, Ind. Type K silicon rectifiers feature 750 ma to 55 C (no heat sink). They provide axial lead mounting. Mass production results in very low prices to allow wide commercial application. The K series incorporates a positive environmental seal with special epoxy resin. Polarity is identified by color coded resin at each end. Voltage ratings are 100, 200, 300 and 400 v peak inverse. **Circle 416 on Reader Service Card.**



Tantalum Capacitor solid electrolyte

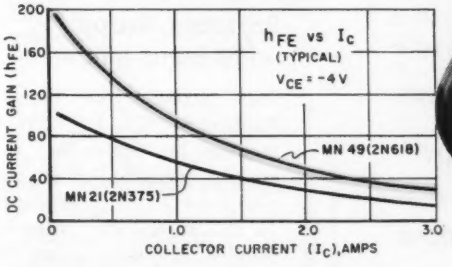
MINITRONICS CORP., 328 Grand St., New York 2, N. Y. Type TQ subminiature tantalum electrolytic capacitor is a metal cased hermeti-

MOTOROLA NOW OFFERS BOTH

HIGH AND MEDIUM GAIN 60-VOLT POWER TRANSISTORS

GENERAL SPECIFICATIONS

TYPE NUMBER	BV_{CBO} volts	BV_{CEO} (min) volts	h_{FE} @ 1A (typ)	G_e db	P_o Class A @ 75°C watts	$f_{\alpha e}$
MN49 2N618	−80	−60	90	40	5	8.5
MN21 2N375	−80	−60	55	37	5	10



Actual Size

for an extensive range of military & industrial applications

Select the Beta-range best suited for your requirements. Both units are supplied to the same stringent specifications and are available, now, in quantities at sensible prices.

use wherever high-voltage power transistors are required.

- Magnetic amplifiers
- DC converters and other switching service
- All audio amplifiers
- Motor controls
- Power supply regulators
- Line voltage regulators
- Servo amplifiers

SAMPLE ORDER 2 EACH OF 2 TYPES—$25.00 available from your local Motorola distributor or from the Phoenix factory.

FOR COMPLETE TECHNICAL DATA concerning these and other performance-proven Motorola Semiconductors—write, wire or phone, Motorola, Inc., 5005 East McDowell Road, Phoenix, Arizona. BRidge 5-4411. Teletype PX 80.

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MOTOROLA SEMICONDUCTORS

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5005 E. McDOWELL
PHOENIX, ARIZONA

Other Motorola Quality Products Include:

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ESterbrook 9-5200

HOLLYWOOD 28, CALIFORNIA
6555 Sunset Boulevard
HOllywood 5-3250

What's under her hat?

It isn't an earring. It's an ACESET® . . a micro-miniature, precision, wire-wound potentiometer featuring small pot size with big pot performance! Only ½" in diameter and 5/16" in body length, the ACESET excels in a combination of all around top performance characteristics. Heat dissipation, for example, is 2 watts at 60° C. Other specification information is listed below.

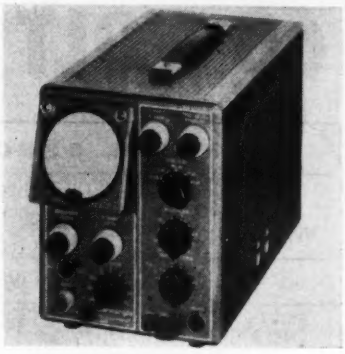
Improved performance at lower cost has been achieved in these micro-miniature units by mass producing to standard specifications. You can select from nine different resistance values between 100 and 25,000 Ohms. Shipments are guaranteed within 24 hours of receipt of order. Call, wire or teletype Dept. F at Ace Electronics Associates, Inc., 99 Dover Street, Somerville, Mass. SOmerset 6-5130. TWX SMVL 181

MECHANICAL SPECIFICATIONS	ELECTRICAL SPECIFICATIONS
One piece precision-machined metal case	Heat Dissipation: 2 watts at 60° C.
Passivated stainless steel shaft	Voltage breakdown: 1,000 VDC
Self-contained locking device	Electrical Angle: 325° nominal
Panel anti-rotation pin	Temp. coefficient of resistance wire: 20 ppm
Mechanical rotation: 330° nominal	Resistance tolerance: ± 10%
Size: ½" diameter x 5/16" body length	Linearity: ± 5%

ACEPOT®
ACETRIM®
ACESET®
ACEOHM®
ACE ELECTRONICS ASSOCIATES, INC.

cally sealed unit, containing solid materials exclusively. The capacitor cannot leak or corrode even if the seals are damaged or destroyed.

Type TQ capacitors operate over the temperature range of −80 C to +85 C with a capacitance variation of only ±10 percent. The dissipation factor does not exceed 0.05 at 1,000 cps and 25 C. The leakage current at 25 deg is less than 0.05 $\mu a/\mu f/v$ or 0.1 μa, whichever is greater, measured after five minutes at rated d-c working voltage applied through a 1,000 ohm resistor to limit the charging current. The type TQ is a polarized capacitor to be used where no reversal of potential occurs. The case is the negative terminal. **Circle 417 on Reader Service Card.**



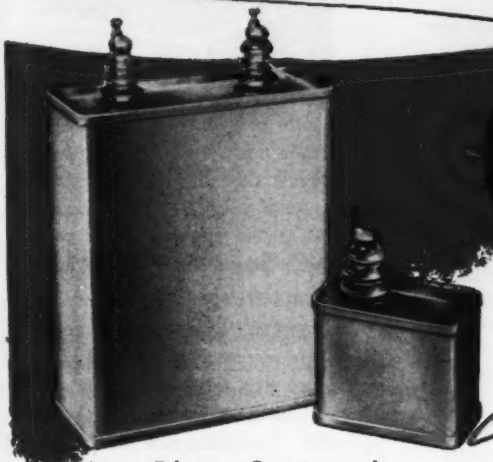
Portable Scope wide-band unit

The Scopes Co. Inc., 20-02 Raphael St., Fair Lawn, N. J., announces the Serviscope, an inexpensive wide-band portable precision oscilloscope weighing only 16 lb. It features balanced, d-c coupled amplifiers giving flat response to 6 mc (− 3 db) and having a rise time of better than 0.06 μsec for less than 2 percent overshoot. Both fully automatic sync and precision trigger level selection are provided as well as tv field and frame sync selectors.

Built-in voltage and time calibrating signals facilitate quantitative measurements and X-expansion, about the center, gives a 50 cm effective trace length. Eighteen preset calibrated sweep speeds and frequency-corrected attenuator per-

For *HIGH* Insulation Resistance and Low Power Factor

AEROVOX Polystyrene Capacitors are wound with NATVAR Styroflex®



Aerovox Polystyrene Capacitors are designed for applications where stability and low dielectric absorption are essential—such as computing devices, tuned circuits demanding highest Q standards, capacitance bridges, and laboratory standards. They are available in many case styles and in capacities from 0.001 mfd to 25. mfd. and in voltage ratings from 100 VDC to 1600 VDC.

AEROVOX Corporation, with ten plants from coast to coast, have been manufacturing capacitors since 1922. As leaders in the field, they have been quick to take advantage of new and better materials, and to anticipate the demands of the fastest growing industry—electronics.

They use Natvar Styroflex because it has all of the outstanding properties of polystyrene, plus complete flexibility, toughness and uniformity.

Natvar Styroflex is available in standard thicknesses from .0004" to .006" in rolls from ½" to approximately 10" in width. Ask for data sheet St-1.

Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Isoglas® sheet, tape, tubing and sleeving
- Vinyl coated and varnished tubing and sleeving
- Extruded vinyl tubigg and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 23

NATVAR CORPORATION

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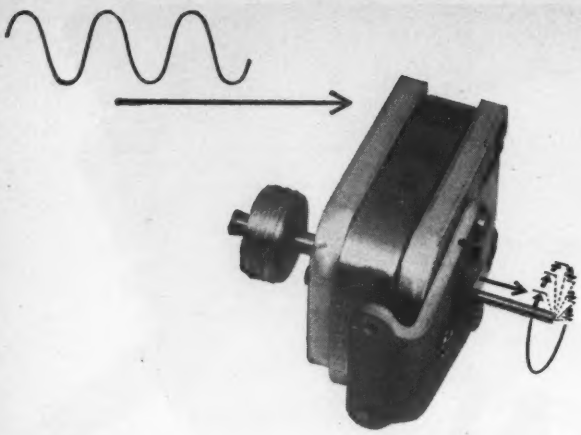


99% magnetic stepping motor—

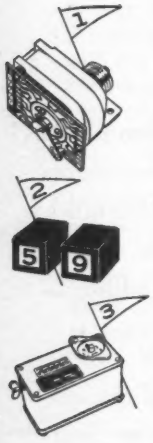
1% moving part (TOUCHES ONLY BALL BEARINGS)

...8000 STEPS PER MINUTE

...INSTANT START, NO SLIP, NO CLATTER

...IT WORKS

THE SIGMA CYCLONOME® STEPPING MOTOR* behaves like a 10-pole synchronous motor, but because of small inertia and high torque it comes to a dead stop between *each half cycle* up to rated maximum of 130 cps. It continues to run synchronously at frequencies well above this maximum, but eventually fails to stop on command on a selected pole.



Since stopping and starting torques are roughly equal, it makes a good counter of cycles or pulses. It accepts sine waves or square pulses, but requires reversals. These reversals may be provided by straight AC signals, DC pulses supplied alternately to separate windings, or DC pulses to one winding with a reference or bias DC in the other.

As proof that this dandy little motor works and can do some useful jobs, three "for instances" that we've built are shown. In (1), some rather elaborate switching is done by a commutating switch driven by the motor. At (2), it functions as a self-checking digital readout switch. In the third example (3), the motor is housed with and drives a 6-digit Veeder-Root register at rates up to 8000 CPM (sold for some time as the Sigma Cyclonome Counter).

*Pat. app. for

TYPE 12D CYCLONOME STEPPING MOTOR SPECS INCLUDE:

TORQUE OUTPUT: approximately 100 gram-cm. for every 18° of rotation (optimum input signal)

INERTIA: 0.6 gram-cm².

INPUT POWER: ½ to 12 watts depending on speed requirements

SIZE: 2⅝" x 2⅛" x 1⅞"

Why you would want to get shaft positions out of electrical cycles is, of course, your business, but there is a thinly disguised feeling around here that (maybe?) one of these gadgets might be just what you've been looking for. If you can withstand the Tumult and get past the Lions, you can see a Cyclonome Motor stepping at BOOTH 2628-2630, at the athletic contest in March. If not, write for Bulletin.

SIGMA INSTRUMENTS, INC.

62 Pearl Street, So. Braintree 85, Massachusetts

mit time and voltage measurement over the ranges 0.1 μsec/cm to 0.5 sec/cm and from 20 mv to 250 v, a-c or d-c, respectively.

With dimensions of 6½ in by 8½ in. by 13½ in. overall the Serviscope offers expensive facilities in a small low cost package and is available for immediate delivery. **Circle 418 on Reader Service Card.**

D-C Supplies transistorized

SORENSEN & CO., INC., Richards Ave., South Norwalk, Conn. Six new all-transistor low-voltage, high-current d-c supplies are now available. First of a new line called Q Nobatrons, they offer performance on a par with that of the B-type high-voltage d-c supplies. Features include low ripple, fast response, transient-free performance, adjustable output, wide input frequency range, complete self-protection, cabinet or single or dual rack mounting, isolated output, small size and low cost.

They are said to be ideal for such applications as computer circuits and strain gage bridges. The units have a wide (2:1) range of output voltage. Exclusive circuit design prevents damage to transistors even if output is short circuited. Because no resonant regulators are used, Q-Nobatrons are insensitive to input frequency changes. Either positive or negative output may be grounded, or the output may be floating.

Input voltage of these d-c supplies is 105-125 v a-c single phase. Output voltages are 4.5-8 v, and 18-36 v. Output current ranges from 0-0.5 ampere to 0-4 amperes. Output voltage regulation is

Lowest Prices in the Industry for Highest-Quality OVENS

AMINCO'S famous forced-convection ovens solve the big problems in today's research and industrial laboratories; . . . they eliminate hot and cold pockets; they provide precise temperature control; and minimize power consumption.

The many styles and sizes listed at right employ motor-driven blowers which produce movement of a large volume of heated air, horizontally across the work chamber. This, together with the circular arrangement of the heaters, results in uniform distribution throughout the entire work chamber.

All ovens listed are provided with positive locking latches, adjustable perforated shelves, and a removable control panel.

On special order, pyrex inner doors, explosion-proof fittings, and blow-out safety panels can be supplied.

Complete information furnished upon request, in new bulletin 34-37-Z

Immediate delivery from Stock!

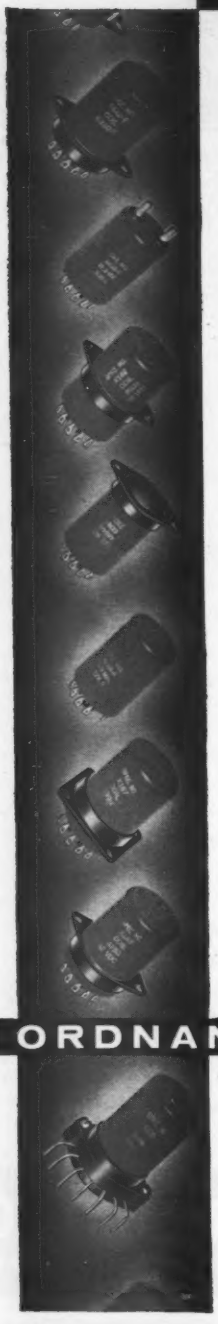
Compare these prices with any other top-quality ovens—the savings per cubic foot are substantial!

Description	Price per Cu. Ft.	Total Price
4-3510 Oven, with cold-rolled steel interior and Linco-flek exterior. 115 volts; size: 19 x 19 x 19 in.	$134.61	$ 525
4-3521 Oven, with cold-rolled steel interior and Linco-flek exterior. 230 volts; size: 37 x 19 x 25 in.	71.80	718
4-3540 Oven, with Linco-flek exterior, and stainless steel interior. 230 volts; size: 19 x 19 x 19 in.	161.53	630
4-3541 Oven, with Linco-flek and stainless steel interior. 230 volts; size: 37 x 19 x 25 in.	87.30	873
4-3560 Oven, with stainless steel interior and exterior. 230 volts; size: 19 x 19 x 19 in.	211.02	823
4-3561 Oven, with stainless steel interior and exterior. 230 volts; size: 37 x 19 x 25 in.	114.80	1148
4-3516 Oven, with Linco-flek exterior and cold-rolled interior. 230 volts; size: 19 x 19 x 19 in.	134.61	525
4-3522 Oven, with Linco-flek exterior and cold-rolled interior. 230 volts; size: 37 x 25 x 37 in.	42.27	837
4-3530 Oven, with Linco-flek exterior and stainless steel interior. 115 volts; size: 19 x 19 x 19 in.	161.53	630
4-3542 Oven, with Linco-flek exterior and stainless steel interior. 230 volts; size: 37 x 25 x 37 in.	54.50	1079
4-3550 Oven, with stainless steel exterior and interior; 115 volts; size: 19 x 19 x 19 in.	211.02	823
4-3562 Oven, with stainless steel exterior and interior; 230 volts; size: 37 x 25 x 37 in.	64.39	1275

AMERICAN INSTRUMENT CO., INC.

8030 GEORGIA AVENUE, SILVER SPRING, MARYLAND

the head of the family



The Couch Type 4A relay heads a family of rugged relays — relays that can withstand the extremes of shock, vibration, and acceleration — all because of a unique patented rotary armature design. The 4A design will answer your dry circuit switching problems too. Our Bulletin 132 will tell you more. Write for it today.

IMPORTANT SPECIFICATIONS

Contacts: 4PDT (4 Form C)

Size & weight:
1 3/32" D x 1 1/2" H, 3.2 oz.

Pull-in power: ½ watt

Ambient temperature:
-65°C to 125°C

Vibration resistance:
20G, 5 to 2000 cps

Shock resistance:
75G operating
200G non-operating

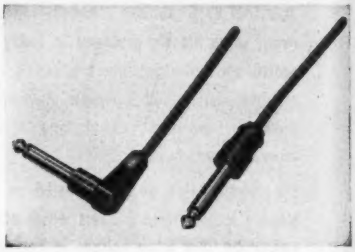
Illustrated on the right are some of the many possible mounting variations available.

Couch ORDNANCE INC.

A Subsidiary of S. H. Couch Co., Inc.

3 Arlington Street
North Quincy, Mass.

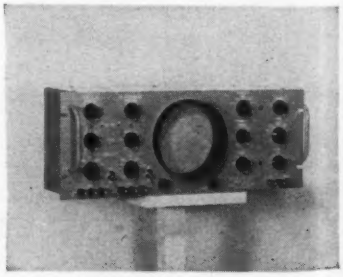
± 0.25 percent for line and load changes combined. Ripple is 0.01 percent for all but one unit, which has a 0.02 percent ripple. Typical recovery time is 50 μsec. Ambient temperature extends from 0-40 C. Typical output impedance at 1,000 cps ranges from about 0.003 to about 0.02 ohm. **Circle 419 on Reader Service Card.**



Phone Plugs molded to cable

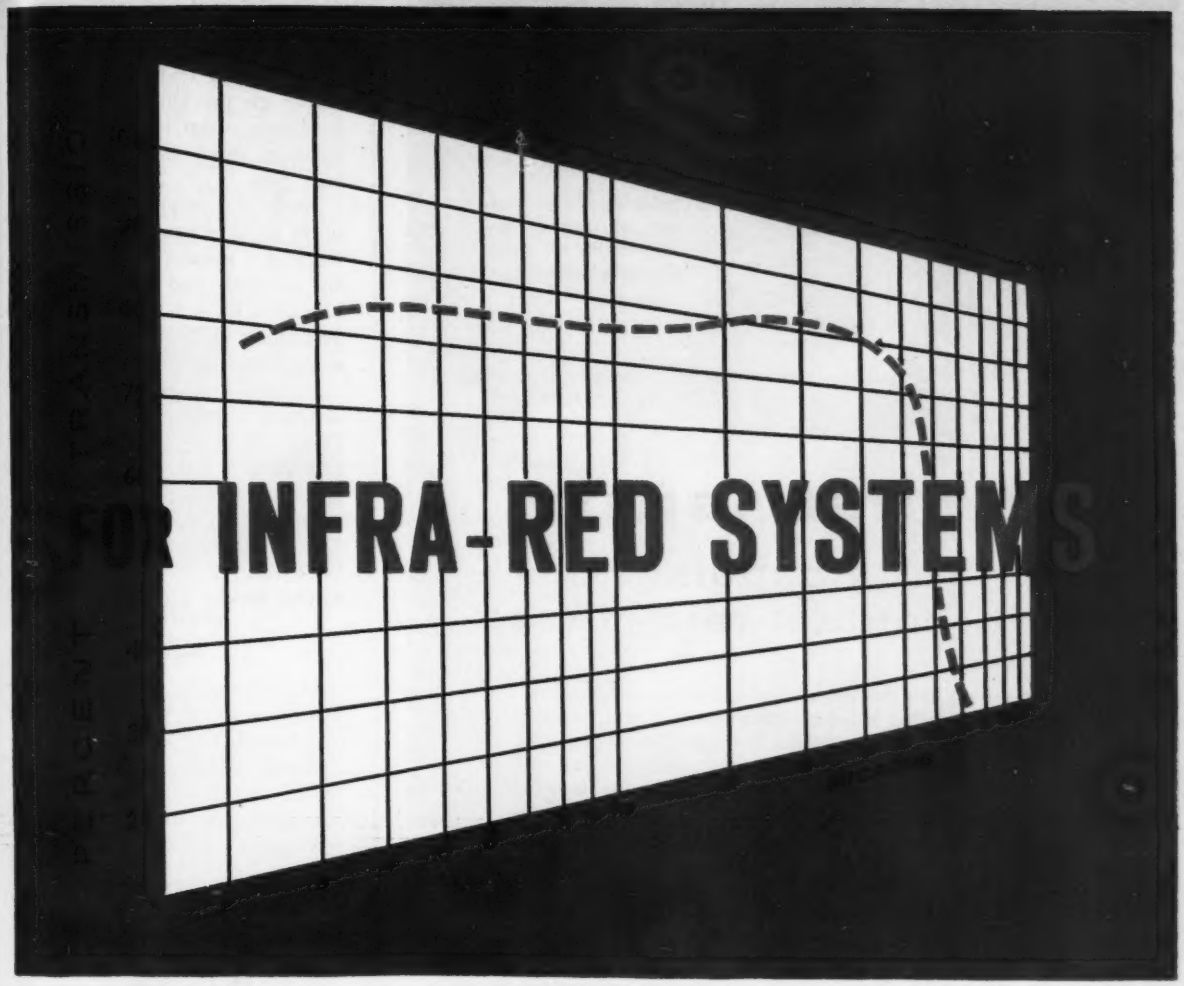
SWITCHCRAFT, INC., 1328 N. Halsted St., Chicago 22, Ill., adds to its line of components phone plugs molded directly to 2-conductor shielded cable. These are assembled in standard cable assemblies of the type often used in audio equipment for interconnecting amplifiers, microphones and so on. They are available in straight or angle types, as illustrated.

These assemblies will be available in packaged units or for specific requirements with plugs molded to special cables. **Circle 420 on Reader Service Card.**



Oscilloscope meets MIL-O-15525D

JAMES S. SPIVEY INC., 4908 Hampden Lane, Washington 14, D. C. Model 85-A oscilloscope is designed to fulfill the requirements of the automatic communications



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Priced competitively with sintered materials

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Strength at elevated temperatures
High melting point—2040° C.
Excellent IR transmission at high temperatures (above 500° C.)

LINDE Sapphire is available as . . .
Windows
Domes
Rods and tubes
Special shapes—to order

For more information about LINDE Sapphire . . . Write "Crystals Dept. BD-32," LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited

Linde

UNION CARBIDE

ENGINEERS AND SCIENTISTS interested in working in Synthetic Crystal Sales & Development, contact Mr. A. K. Seemann, Linde Company, 30 E. 42nd St., New York 17, N.Y.

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

S-D Type 180 Midget D-C Telephone Style RELAY

featuring a large number of contact arrangements in small size at minimum cost.

NEW RELIABILITY

for a popular multi-contact relay type

The big story about this popular midget relay type is not that it is new . . . but that Struthers-Dunn now makes it. Material and design improvements scored by S-D engineering spell maximum dependability and long life—yet at no price increase.

As illustrated, 16 flexing contact springs can be supplied with 8 springs in each of two stacks. Standard relays withstand ambient temperatures to 85°C. Special types for ambients of 125°C. are available. Minimum power requirements are on the order of 100 milliwatts per pole.

A-C VERSIONS for continuous duty can be supplied.

FOR MILITARY APPLICATIONS, SD Type 180 Relays are widely used for ground and aircraft electronic and communications equipment.

FOR COMMERCIAL USES. Type 180 relays provide maximum dependability for the numerous contact arrangements required for computers, instruments, signalling and annunciator systems and similar low power uses.

Data Bulletin No. 2180 request

Now! **STOCK DELIVERIES** from the factory on many of the S-D 5,348 relay types.

IMMEDIATE LOCAL DELIVERIES on many of the most popular types. Write for name of your nearest distributor.

STRUTHERS-DUNN, Inc.
Pitman, N. J.

Makers of the world's largest selection of relay types

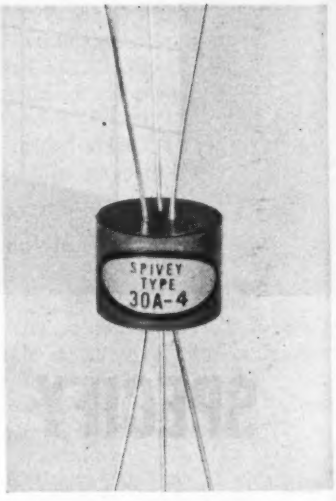
Sales Engineering Offices in: Atlanta • Boston • Buffalo • Chicago • Cincinnati Cleveland • Dallas • Dayton • Detroit • Kansas City • Los Angeles • Montreal • New Orleans • New York • Pittsburgh • St. Louis • San Francisco • Seattle • Toronto

field and allied operational systems. Special emphasis has been placed on providing superior low frequency sweep linearization and balanced input d-c amplifiers of high gain.

Horizontal sweep range is 3 cps to 40 kc in 4 bands with a minimum of 5 percent frequency overlap on each end of each band. Linearity is ± 1 percent on all frequencies up to 5 kc; ± 2 percent above that.

Vertical and horizontal amplifiers have 1 ground and 2 balanced inputs through 5-way binding posts spaced ¾ in. on centers. Input sensitivity is 5 mv/cm to 500 v/cm.

Size is 19 in. wide by 7 in. high by 19 in. deep. **Circle 421 on Reader Service Card.**



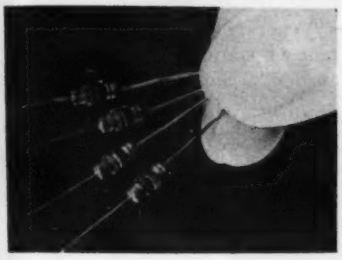
Pulse Transformers miniature type

James S. Spivey Inc., 4908 Hampden Lane, Washington 14, D. C. Type 30A miniature pulse transformers are designed to produce exceptionally fast pulse rise and recovery time. This is accomplished by using ferrite cores that have high effective permeability for abrupt changes in current and winding coils with very tight inductive coupling between windings on these cores.

The transformers are designed to meet MIL-T-27A specifications. They are epoxy, resin encapsulated

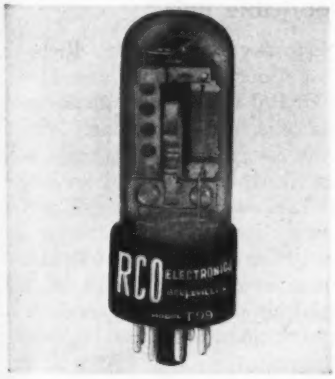
for plug-in or printed-circuit and conventional-wiring applications.

Rise time is as low as 0.005 μsec, depending on transformer type and circuit; pulse repetition rate, up to 4 mc; operating temperature, −55 C to +125 C. **Circle 422 on Reader Service Card.**



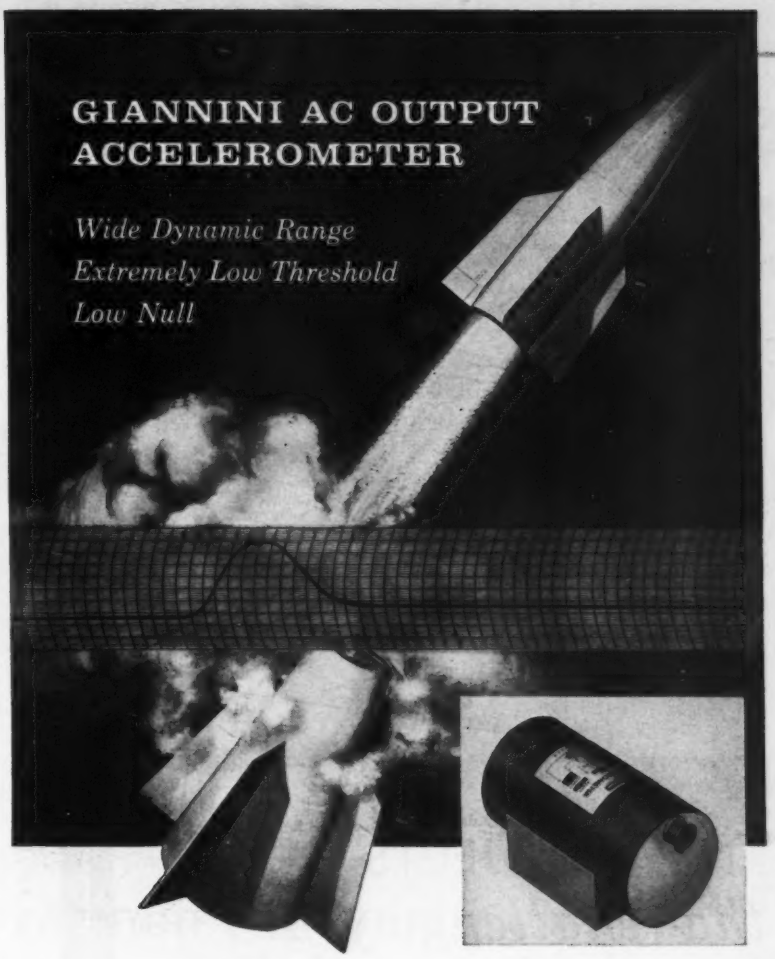
Silicon Rectifiers tiny glass type

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass, has available the 1N645, 1N646 and 1N-648 tiny glass silicon rectifiers. These have peak inverse ratings from 225 to 500 v and are capable of handling 400 ma average forward current at 25 C or 150 ma at 150 C. **Circle 423 on Reader Service Card.**



Time Delay Relay thermal type

R.C.O. ELECTRONICS, 145 Valley St., Belleville, N. J., has in production a highly effective thermal time delay relay, model T-99. Actuated by heater and hermetically sealed for maximum stability, it is unaffected by moisture, altitude or dust



ACCURATE, CONSISTENTLY RELIABLE AC output, proportional to linear acceleration, is provided by this new Giannini accelerometer. Available in ranges from ±1 g to ±20 g, the instrument has a full scale output of 6 volts which may be fed directly into a relatively low impedance with little or no phase shift.

NULL VOLTAGE IS 0.015 VOLTS, of which at least 90% is harmonic, assuring a wide dynamic range for the instrument. With a basic threshold sensitivity as low as 0.0001 g/g, input accelerations on the order of 0.0017 g's will provide a 10 millivolt change in output.

NO COULOMB FRICTION IS EXHIBITED in this design, bearings are eliminated by suspending the mass between two disc springs. Acceleration inputs move the magnetically damped mass, causing a proportionate change in the output voltage of a differential transformer. Cross-talk effect is minimum (0.003 g/g at 10 g cross acceleration on a 1g instrument); repeatability and hysteresis are below thresholds of measuring equipment.

IDEAL SECOND ORDER SYSTEM RESPONSE is achieved in the Model 24614 by magnetic eddy-current damping. The hermetically sealed instrument is oil-filled for stability of output under vibration. Specially designed and constructed for use in critical airborne control, stabilization, and flight test applications, the instrument is readily adapted to telemetering.

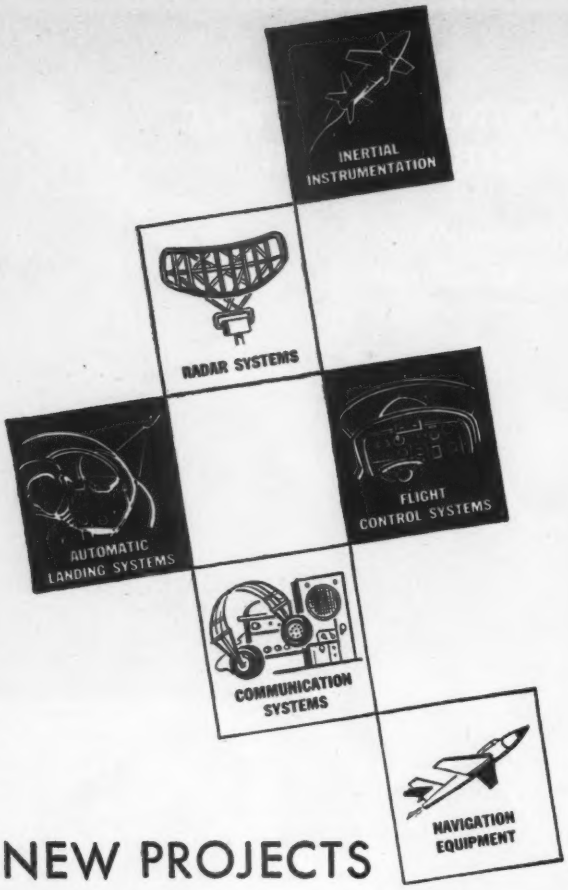
Giannini measures & controls:

ω	β	θ	ψ	τ	v	φ
δ	Ω	ω	h	P	ΔP	T
T_s	P_s	Qc	M	T_o	P_T	TAS

PRECISION INSTRUMENTS AND CONTROLS

Giannini

G. M. GIANNINI & CO., INC., 918 EAST GREEN STREET, PASADENA, CALIF.



NEW PROJECTS
that challenge your avionics capabilities

New and expanded contracts of a long-term nature have created a number of challenging, high-level openings for electronics engineers in Bell Aircraft's Avionics, Aircraft and Special Weapons Divisions.

These openings embrace interesting design and development problems which will afford full scope to your creative ingenuity with unusual opportunities for rapid advancement and professional recognition.

If you have a B. S. or higher degree in Electrical Engineering with experience in the fields of servo-mechanisms, inertial guidance, gyros and advanced systems analysis, you'll find good listening in what the rapidly expanding divisions of Bell Aircraft have to tell you. Top salaries commensurate with your background, good living and liberal fringe benefits.

Please contact Bell representatives at the I. R. E. Show, booths 1328-30 or write: Supervisor of Engineering Employment, Dept. H-21, BELL AIRCRAFT CORPORATION, P. O. Box One, Buffalo 5, N. Y.

BELL Aircraft corp
BUFFALO N.Y.

. . . ideal for use in military, commercial and communications equipment.

The delay relay operates on a-c, d-c or pulsating currents . . . 2 seconds to 3 minute delay periods. Vibrations and shocks will not damage the unit. When subjected to ambient temperature ranges from −60 C to +85 C, the relay delay interval varies slightly from room temperature delay periods.

Whether operation is intermittent or continuous, all relays are assured a useful longevity. Rapid installation is made possible by use of the standard intermediate shell 8-pin octal base. Special heater voltages are available for special requirements. **Circle 424 on Reader Service Card.**

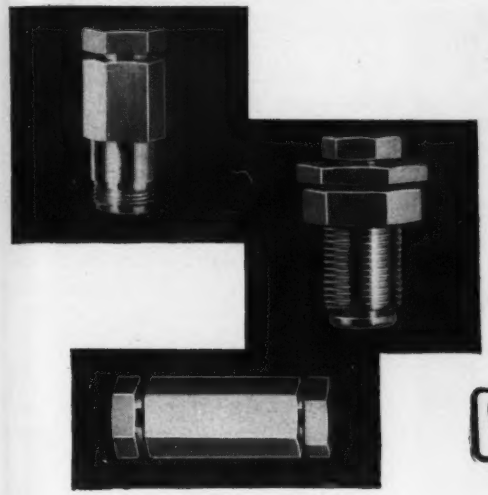
Frequency Changer portable unit

Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn. Model FCR100 is a new low-impedance, portable frequency changer with a wide range of output frequency, excellent waveform, and low audio and radio noise. It is an ideal power supply for equipment drawing up to 100 va and operating best at frequencies other than that of the available main power source. It is also recommended for use in testing equipment over a range of frequencies anywhere between 45 and 2,000 cps.

Because of its low output distortion, it is said to be an excellent servo supply. Wide output-frequency range allows it to be used not only in 60-cycle applications, but also with higher frequency aircraft and missile components. Versatility of the unit is further enhanced by an auxiliary input which

connectors by **KINGS**

for cables by **PHELPS DODGE**



KINGS, the first name in connectors, introduces its new line of fittings for Foamflex, Styroflex and Spirafil cables. These are the finest connectors for the finest line of high frequency cables manufactured by Phelps Dodge Copper Products Corp. Adapters for RG-/U are available.

- Low VSRW
- Uniform Electrical Properties Over Wide Temperature Variations
- Excellent Frequency Response
- Unlimited Operating Life

WRITE FOR DETAILS

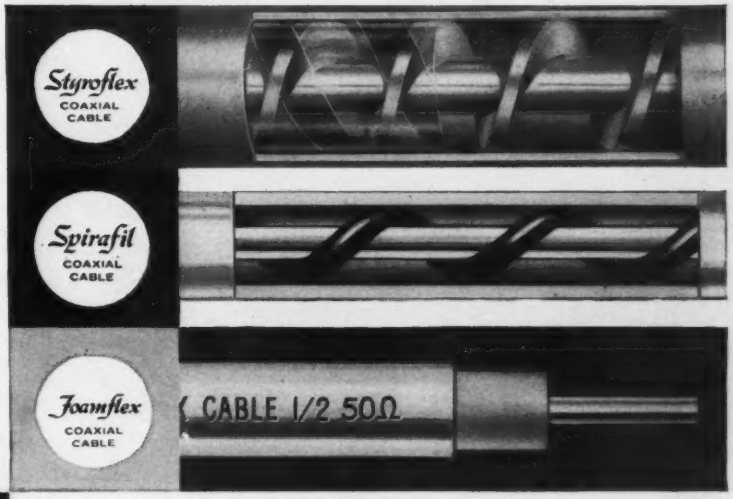
KINGS *Electronics* CO., INC.

40 MARBLEDALE ROAD, TUCKAHOE 7, N. Y.

CIRCLE 180 READERS SERVICE CARD

FINEST LINE OF HIGH FREQUENCY CABLES IN THE COMMUNICATIONS FIELD!

- No radiation
- Low attenuation
- Excellent frequency response
- Uniform electrical properties over wide temperature variations
- Unlimited operating life
- Continuous 1000′ lengths



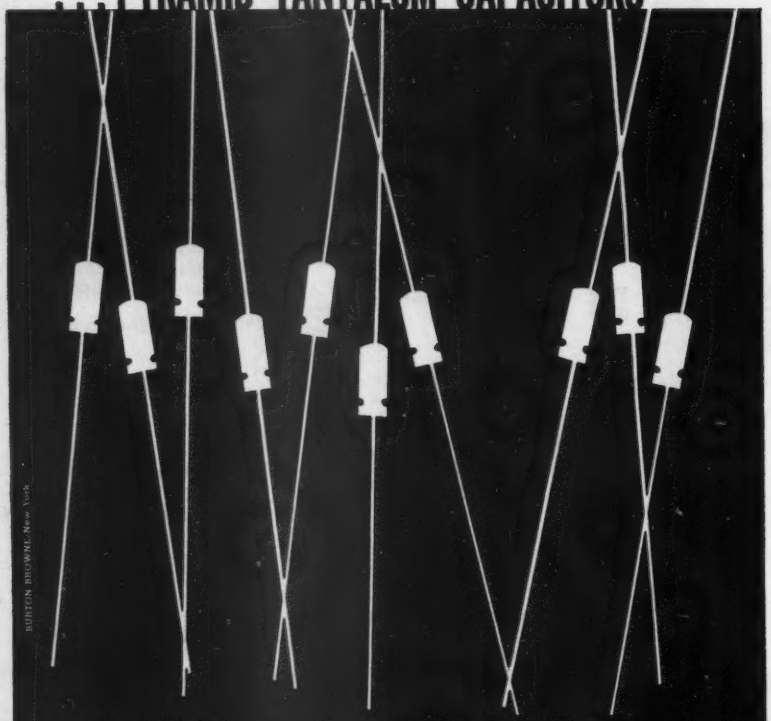
PHELPS DODGE COPPER PRODUCTS CORPORATION

300 PARK AVENUE, NEW YORK 22, N. Y.

CIRCLE 181 READERS SERVICE CARD

UP TO 1000 MFD-VOLTS IN LESS THAN 2/100 OF A CUBIC INCH

... PYRAMID TANTALUM CAPACITORS



Pyramid Tantalum slug capacitors are miniaturized to provide maximum space economy.

New Pyramid Tantalum slug capacitors have cylindrical cases and contain a non-corrosive electrolyte. Due to the special construction of materials used in the manufacture of Pyramid Tantalum slug capacitors, these units are both seep and vibration proof. In addition, this type of capacitor assures long service life and corrosion resistance – made to meet MIL-C-3965 Specifications.

Commercially available immediately, these new Pyramid Tantalum capacitor units have an operating range between –55 C to 100 C for most units without any de-rating at the higher temperature.

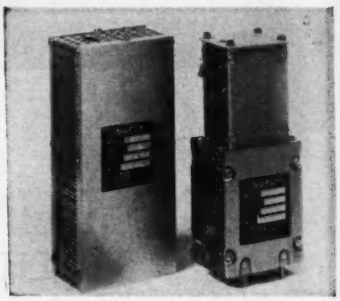
To obtain complete engineering data and prices for Pyramid Tantalum slug capacitors, write to: Pyramid Research and Development Dept., Pyramid Electric Company, 1445 Hudson Boulevard, North Bergen, New Jersey.

CAPACITORS – RECTIFIERS
FOR ORIGINAL EQUIPMENT –
FOR REPLACEMENT

PYRAMID
ELECTRIC COMPANY
NORTH BERGEN, N. J.

allows an external signal to be applied to its oscillator circuit. This permits the output frequency to be set with a high-precision frequency standard.

Other features include input voltage range of 105-125 v at 45-65 cps; output voltage range of 0-130 v with ±1 percent regulation for line or load; output frequency regulation of ±1 percent normally, ±0.01 percent with a built-in frequency standard or any accuracy obtainable with an external frequency standard; frequency drift of less than 1 percent in 24 hours; power factor of unity to 0.7 lagging at 100 va, unity to 0.5 lagging at 50 va, and fully inductive at 25 va; output distortion 1 percent maximum for 75-125 v output; and 0-40 C ambient temperature range. **Circle 425 on Reader Service Card.**



Power Supplies transistor regulated

ELCOR, INC., P. O. Box 354, McLean, Va., announces a new series of transistor regulated power supplies for strain-gage bridges and other applications requiring a low-noise ungrounded power supply. Available are nine different models for 117 v, 60 cycle input, with output voltages ranging from 10 v to 50 v in steps of 5 v. Output current ratings range from 150 ma d-c at 10 v to 40 ma d-c at 50 v. Dimensions including the shield are 1⅛ in. by 2⅛ in. by 5⅛ in., and weight is approximately 1 lb.

A novel feature is a special transformer construction that provides low shunt capacitance and very high leakage resistance from the output terminals to ground, permitting use of the supply as a floating source of d-c power in

Rex Rheostat Company
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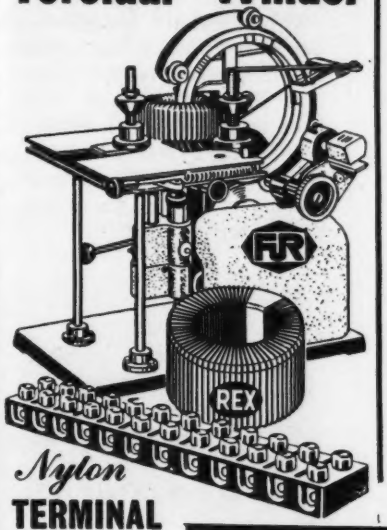
Automatic
Toroidal Winder



Nylon
TERMINAL BLOCKS

BOOTHS **4407-9** AT THE **I. R. E.** SHOW

new AUMANN High Precision

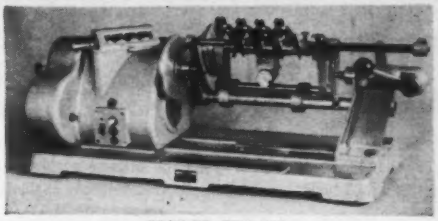
Latest in

DESIGN
PERFORMANCE
VERSATILITY

for high production and laboratory

All types of automatic and semi-automatic

COIL WINDING MACHINES
TOROIDAL WINDING MACHINES for fine or heavy wires
ARMATURE WINDING MACHINES
CONDENSER WINDING MACHINES
WIRE RE-WINDING MACHINES
TAKE-UP and WINDING FRAMES with constant tension
MACHINES to SPECIFICATIONS



MODEL WG 300

- *Wire ranges AWG #12 to AWG #57*
- *Infinitely adjustable pitch and traverse*
- *Variable speeds up to maximum 15,000 rpm*
- *Single and multiple winding; wire guides can be added at convenience*
- *With or without bedplate and tailstock*

OPTIONAL:—Semi-automatic paper interleaving—Automatic stop after each first and second layer—Automatic stop after each first and sixth layer—Progressive shortening of layers (for trapezoidal winding)—Automatic speed reduction at end of layers—Driven tailstock—Intermediate support for multiple winding of coils that have to be clamped—Set of two winding mandrels on turret; while one mandrel is engaged for winding, the other is emptied and newly prepared.

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theory * design * performance
of electronic circuits

ELECTRONIC SEMICONDUCTORS

Just Published. A rigorous and systematic introduction to semiconductor physics, developing the subject logically from simple concepts and giving clear pictures of the conduction mechanism of electronic semiconductors within the framework of the *band model*. Among the book's outstanding features are the treatment of acceleration of electrons, the Zener effect, etc. Book is a translation of the 2nd German edition of *Elektronische Halbleiter* by **Eberhard Spenke.** Translated by **D. Jenny, H. Kroemer, E. G. Ramberg,** and **A. H. Sommer,** RCA Laboratories, **430 pp., 163 illus., $11.00**

RANDOM SIGNALS AND NOISE

Just Published. An introduction to the statistical theory underlying the study of signals and noises in communications systems. Contains an introduction to probability theory and statistics, a discussion of the statistical properties of the Gaussian random process, a study of the results of passing random signals and noises through linear and nonlinear systems, and an introduction to the statistical theory of the detection of signals in presence of noise. **By William B. Davenport, Jr.,** and **William L. Root,** Lincoln Laboratory, M.I.T. **393 pp., illus., $10.00**

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Just Published. Covers the topics most directly needed for a clear understanding of methods used in numerical solution of differential equations, both ordinary and partial, and in the solution of integral equations. Clearly explains the use of finite-difference methods in obtaining numerical solutions to problems—emphasizing procedures which can be most readily programmed for an electronic digital computer. Many helpful techniques such as the use of lozenge diagrams for numerical differentiation and integration are supplied. **By Kaiser S. Kunz,** Ridgefield Research Lab. **381 pp., 40 illus., $8.00**

ELECTRON TUBE CIRCUITS

New 2nd Edition Just Published. Discusses and evaluates the fundamental properties of electron tubes and their circuit operations—analyzes tuned and untuned amplifiers—and takes up in detail circuits essential to modern electronic systems such as voltage, video, and power amplifiers; waveform generators; oscillators; modulators, etc. Scores of practical examples show you best applications of theory. **By Samuel Seely,** Case Inst. of Technology. **2nd Ed. 695 pp., 739 illus., $10.50**

BASIC FEEDBACK CONTROL SYSTEM DESIGN

Just Published. Bases the study of feedback control system design on complex frequency plane analysis—the root-locus. A wide range of servo transducers and components are covered. Recent advances covered include a section of gyroscopes and force-balance transducers, inertial navigation; analysis of nonlinear systems such as the describing function technique and phase plane analysis. Frequency methods, such as Nyquist and Bode, are included. **By C. C. Savant,** U. of Southern Cal. **418 pp., illus., $9.50**

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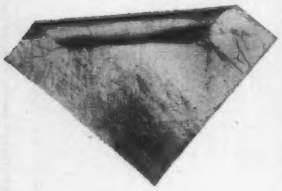
microwave absorbers by McMillan

McMillan Industrial Corporation makes various materials for the absorption of microwave energy, for indoor or outdoor use and for ground or airborne applications. Listed below are the three most popular absorbers, their typical applications, specifications and characteristics.

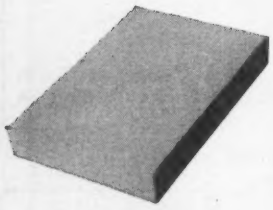


TYPE "T"
THIN — FLEXIBLE

Especially adaptable for airborne applications, the type "T" is an extremely versatile absorber where space and weight limitations are essential. Easily formed, it is impervious to effects of moisture, hydraulic fluids, gasoline etc., when edge sealed.

SPECIFICATIONS

Frequencies:	2500 to 35,000 MC.
Bandwidth:	±3%
Power Reflection Coefficient:	
Perpendicular Polarization	1%
Parallel Polarization	2%
Perpendicular & Parallel Polarization	2%
Power Dissipation:	2 watts/sq. in.
Temperature Range:	—62°F to 172°F
Thickness & Weight:	at 9375 MC., 3/16" thick, 4.7 oz./sq. ft. at 5400 MC., 1/4" thick, 5.7 oz./sq. ft.
Standard Sheet Size:	18" x 36".



TYPE "BL" & "BH"
PERMANENT — LIGHTWEIGHT

Two stable absorbers whose high performance and long life is not affected by moisture, humidity and dust. Type "BL" is fine for walls, ceilings and test panels. Type "BH" is excellent for test room floors and outdoor installations, as its high absorption characteristics are unchanged when it is walked on.

SPECIFICATIONS

Frequency range:	1000 to 35,000MC.
Power reflection coefficient:	0.4% at 24,000 MC.
(perpendicular and/or parallel	1.0% at 9,400 MC.
polarization)	2.0% at 5,400 MC.
Power dissipation:	2 watts/sq. in.
Temperature range:	(type "BL") —62°F to 155°F
	(type "BH") —62°F to 175°F
Standard block size:	2" or 4" thick, 4' long, 1' wide
Weight:	(type "BL") .5 lbs./sq. ft.
	(type "BH") .7 lbs./sq. ft.

TYPE "BL-48"
BROADBANDED — PERMANENT

Recommended for use in the low frequency range where permanent attenuation characteristics are required, for both indoor and outdoor applications.

SPECIFICATIONS

Frequency range:	40 to 35,000 MC.
Power reflection coefficient:	2½%
Power Dissipation:	2 watts/sq. in.
(perpendicular and/or parallel polarization)	
Size:	Base — 1' x 2'
	Height — 48"
Weight:	5 lbs./sq. ft.
Temperature range:	—62°F to 155°F

Also available — Type "H" Hair Mat Absorbers in thicknesses from 1" to 8" for frequencies from 500 to 35,000 MC

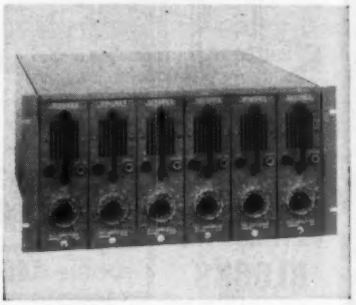
McMillan

BOOTH #3909
I.R.E. SHOW

McMILLAN LABORATORY, INCORPORATED
Brownville Avenue • Ipswich, Massachusetts

bridge circuits or in other applications in which a signal voltage appears between the output of the power supply and ground.

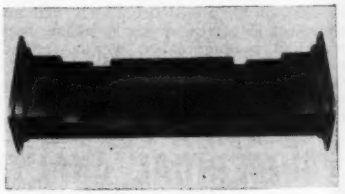
Other features include regulation of 0.4 percent; line regulation of 0.2 percent; output ripple of 0.01 percent; output voltage temperature coefficient of 0.02 percent per deg F; and noise and hum of less than 15 μv per kilohm impedance to ground. **Circle 426 on Reader Service Card.**



D-C Amplifier low noise level

Dynamics Instrumentation Co., 1118 Mission St., South Pasadena, Calif. Loss of data resulting from unexpected overscale input signals is avoided by the unique signal compression feature of the model 1250 d-c amplifier. The low noise level of 3 μv rms for 30 kc bandwidth is achieved by the special low-noise circuit.

Ground-loop and crosstalk problems are minimized by the very high degree of power line isolation. Specifications include voltage gain of 1,000, 2 μv zero stability, and 100 K input impedance. **Circle 427 on Reader Service Card.**



Ferrite Isolator operates in S-band

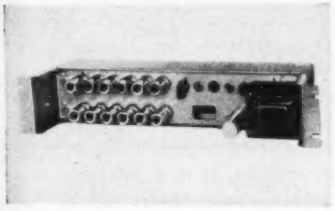
Airtron, Inc., 1096 West Elizabeth Ave., Linden, N. J., has available a special resonant absorption

ferrite isolator for operation in the S-brand region with female type N connectors to meet particular coax systems requirements.

Operating over a frequency range of 2,670 to 2,930 mc, the unit is especially beneficial in applications involving power amplifier type of transmitters because of the high degree of unidirectional isolation of the signal source from reflected r-f energy.

The standard type N (50 ohm) connectors are used on both the input and output of the basic waveguide structure, facilitating the connection of coaxial line systems. Three mounting brackets are used to support the unit permitting the disconnection of cables without removing the isolator and eliminating undue stress on the coaxial lines.

Electrical characteristics are: frequency range, 2,670 to 2,930 mc; isolation, 20 db minimum; insertion loss, 0.8 db maximum; input vswr, 1.20 maximum; and power handling capacity, 10 w average with a 2:1 load vswr. **Circle 428 on Reader Service Card.**



Chain Amplifier r-f distribution

Westbury Electronics, Inc., 300 Shames Drive, Westbury, N. Y., announces a new chain amplifier, model ABB-5 added to its present line of r-f distribution amplifiers. It provides truly broad band amplification of tv and f-m signals in the 15 to 230 mc region with a gain of 20 db and a frequency response flat ± 1.5 db. No matching cables or networks are required for use with 75 ohm cable. It is designed for continuous service with a self-contained power supply, manual gain control, and provisions for the addition of agc.

A unique feature of this amplifier is that complete loss of emission of one or more vacuum tubes does

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QUICK DELIVERY

RELAX.
No need to juggle production schedules when you depend on Deutsch for quick delivery of miniature electrical connectors.

Deutsch specializes in rush orders and prompt delivery of all catalog items. For peace of mind . . . fast . . . specify Deutsch when you need:

Miniature Connectors of all types, including new push-pull, positive locking and sealing units. Ideal for crowded, remote and blind installations. Environmental, and just the thing for umbilical or breakaway units.

Miniature Hermetic Connectors that seal power in, seal unfavorable conditions out. Always on guard against high G forces, heat and cold extremes, vibration and other threats to airborne equipment.

Miniature Rack and Panel Connectors to mate in blind connections without guide pins or match plates. These self-aligning spherical orientation connectors are unaffected by pressure variations.

Miniature Edgelite Panel Connectors – and more.

If you have a delivery problem on your hands, contact your local Deutsch representative or see the Deutschman in Booth 3921 at the IRE Show, New York City Coliseum, March 24-27.

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For Highest Reliability

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Tantalum Capacitors

PP Type, for normal temperature ranges

VP Type, for excessive vibration or shock requirements

HP Type, for high ambient temperatures (to 125°C) and for vibration resistance

PP, VP and HP Types are also available with insulated cases

STA Solid tantalum. Voltage ranges up to 25 volts, D-C. Unusual stability over a wide temperature range

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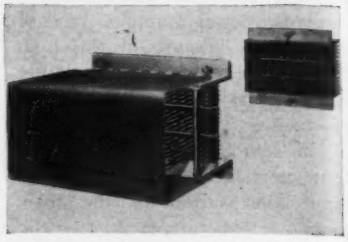
CAPACITORS FANSTEEL RECTIFIERS

FANSTEEL METALLURGICAL CORPORATION

RELIABLE TANTALUM CAPACITORS SINCE 1930

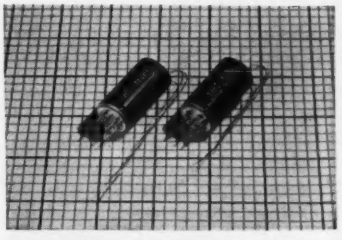
not interrupt the system but only reduces the gain by 1.5 db per tube. The unit is available in regular or rack mounting. **Circle 429 on Reader Service Card.**



Programming Plug has 240 pins

COLEMAN ENGINEERING CO., INC., 6040 W. Jefferson Blvd., Los Angeles 16, Calif., announces the model PR-240 programming plug set. The plug provides 240 pins, readily accessible, tapered to accept taper-lug jumper wires which are applied by hand pressure to effect jumper connections.

Features of the design include guide pins to align and polarize plug with receptacle, provisions for panel mounting the receptacle, and the protective cover for the plug. The unit, the cover of which measures 6 in. wide, 3½ in. high and 2⅛ in. deep, originally intended for use in the company's digital readout systems, is now available as a separate component. **Circle 430 on Reader Service Card.**

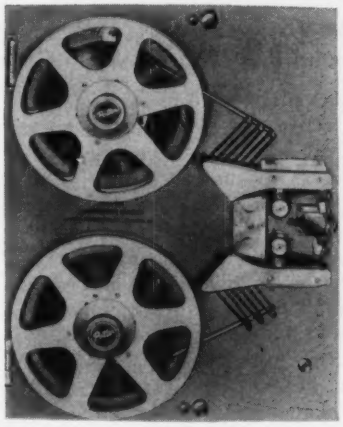


Choppers feature low noise

AIRPAX PRODUCTS CO., Cambridge Division, Cambridge, Md., announces a new type chopper with noise levels below 10 μv in low-impedance circuits. These noise levels are for wide-band noise extending from a few cps up to 40

kc and are measured by a thermocouple voltmeter (true rms reading).

The contacts are rated for operation in dry and nearly dry circuits yet withstand surges as high as 2 ma at 100 v into resistive loads. Drive is rated at either 400 ± 20 cps (type 2300) or 60 ± 6 cps (type 2400) at 6.3 ± 0.6 v rms. Normal operating temperature range is −65 C to +100 C. Units for operation to higher temperatures can be supplied on special order. In usual applications these choppers can be expected to remain within ratings for over 5,000 hours. **Circle 431 on Reader Service Card.**

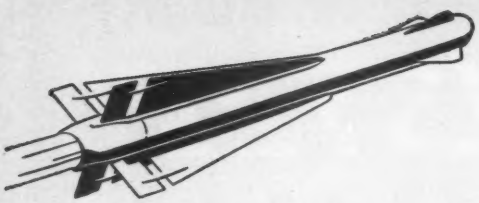


Tape Handler transistorized

Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L. I., N. Y. Model 906 completely transistorized digital magnetic tape handler features rugged dependability and remote control. Both high and low tape speeds are available in ranges of four speeds forward and reverse up to 150 ips. Rewind or search tape speeds are 400 ips.

The machine is capable of continuous cycling at any frequency from 0 to 200 cps without flutter. Start time is 3 milliseconds and stop time has been reduced to 1.5 milliseconds.

A vacuum loop device is used in conjunction with the tensioning system to provide proper tape tension at all times. Other features



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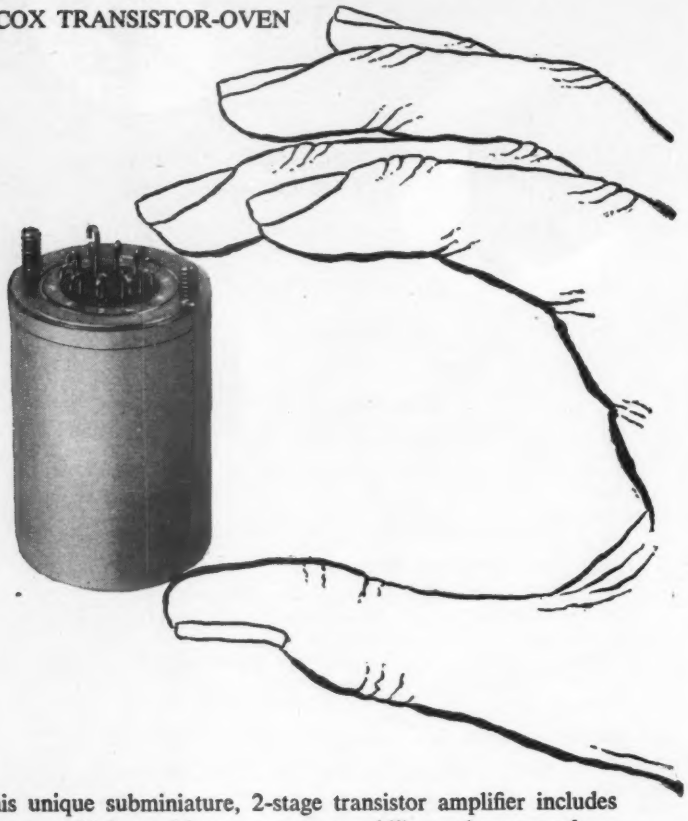
I.R.E. Show, March 24-27

TOP-FLIGHT PERFORMERS

HUGHES FALCON
and
COX TRANSISTOR-OVEN



This unique subminiature, 2-stage transistor amplifier includes an oven which provides temperature stability and warmup from −80°F to +193°F in only two minutes when operating on any voltage between 24 volts and 30 volts.

Designed, developed and produced in quantity by Cox for Hughes Aircraft Company, it forms an essential part of the fire-control system for the Falcon Air-to-Air Guided Missile.

Test Performance charts will be sent upon request.

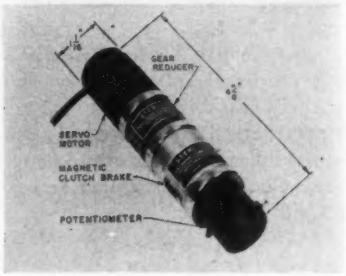
Heaters and Temperature Control for all types of military equipment. Over 2,000 different successful designs in use.

COX & COMPANY, Inc.

115 East 23rd Street New York 10, N.Y.

include in-line threading, end of tape sensing, and tape break protection.

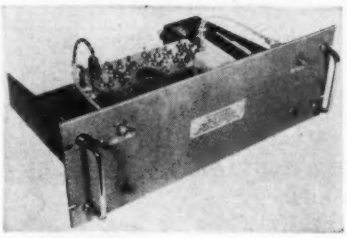
Close packing density, providing up to 47 channels is obtained by use of a Potter high density record/playback head. **Circle 432 on Reader Service Card.**



Servo Package combines four parts

STERLING PRECISION CORP., 34-17 Lawrence St., Flushing 54, N. Y. Model T-950 is a compact servo package combining a servo motor, a gear reducer, a magnetic clutch-brake and a potentiometer. In this particular unit, the motor is driving the potentiometer arm at a speed corresponding to the rotation of radar scanning antenna, (approximately 40 rpm). Upon a given signal the motor is uncoupled and the potentiometer is braked within two milliseconds.

Using the same basic units, various combinations of operational requirements can be accomplished. **Circle 433 on Reader Service Card.**

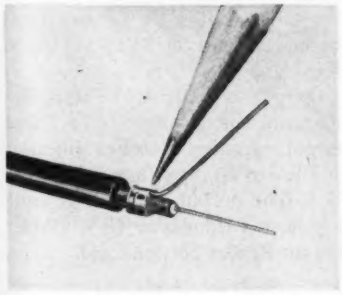


R-F Amplifiers broadband type

APPLIED RESEARCH INC., 76 South Bayles Ave., Port Washington, N. Y., has a new line of broadband r-f amplifiers ruggedly designed for consistently high performance and

low maintenance cost. Model HFW octave r-f amplifiers are said to be a step forward in the application of advanced multipole network theory. The new units provide broadband bandpass amplification covering an octave or greater of frequency in the 40 to 600 mc spectrum with low noise, high gain and low power drain.

GE type GL-6299 co-planar triodes are combined with multipole networks to provide amplifiers with power gains of 5.5 db or greater per stage, with a 300 mc bandwidth. A number of these stages are cascaded to provide gain of 20 or 30 db. The frequency spectrum of 40 to 600 mc is covered by six basic octave r-f amplifiers, having the following frequency responses in megacycles: 40 to 80; 80 to 160; 100 to 200; 160 to 320; 225 to 400; and 300 to 600. **Circle 434 on Reader Service Card.**



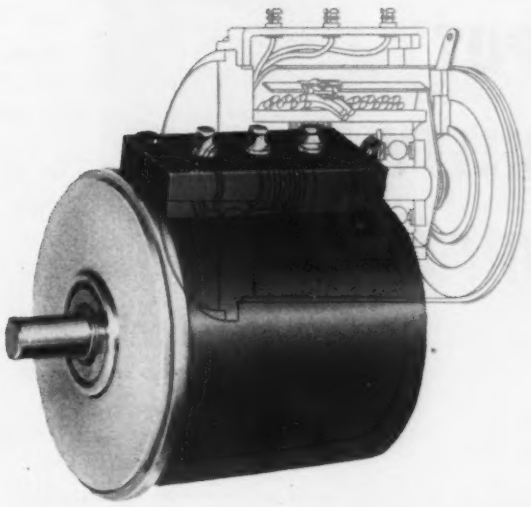
Ferrule for shielded wire

AMP Inc., 2100 Paxton St., Harrisburg, Pa., announces its new Automachine shielded wire ferrule for automated pigtailing.

Designed expressly for grounding the shield braid of coaxial conductors, the new Automachine feeds and attaches Automachine shielded wire ferrules and pigtail simultaneously to shielded wire leads. The Automachine's dual applicator permits attachment of ferrule and pigtail wire to a double ended shielded wire jumper or to two shielded wire leads at the same time, with pigtail wires whose length can be adjusted in the applicator.

The firm reports that the new process will reduce the cost of pig-

.01% Linearity
in Production Potentiometers



LITTON'S MD20 CERAMIC CORE POTENTIOMETER SUSTAINED HIGH ACCURACY — PROVED

MD20 SPECIFICATIONS*

• Up to .01% independent linearity • 1K to 100K standard resistances • Up to .005% resolution depending upon resistance value • 3600° +1° −0° electrical angle • 5 watts power dissipation at 85° C, derates to 125° C • Taps are welded and can be supplied in any location • 90° nominal overtravel • 1.0 oz. in. starting torque • 0.75 oz. in. running torque • 500 oz. in. static stop torque

**For 10 turn: Also available in dual 10 turn; 3 turn, dual 3 turn; 20 turn*

The Litton MD20 meets or exceeds *all* critical military specifications for potentiometers — and, up to .01% linearity is a Litton production-standard specification in this 2" multiturn unit.

Here's how it's done.

■ Ceramic core provides a dimensionally stable, chemically inert and non-hygroscopic foundation.

■ Single-piece machined-aluminum hub furnishes a rugged support and accurate reference.

■ Modified Slope Control delivers a highly accurate servo-controlled winding.

Result — .01% linearity and .005% resolution, as a production standard.

Where your prime requirement is sustained high accuracy, Litton can help you. Please write to Litton Industries, Dept. 1, 215 South Fulton Avenue, Mount Vernon, New York, or to Litton Industries, Dept. 1, 5873 Rodeo Road, Los Angeles 16, California.

Visit Our Booth at N. Y. I.R.E. Show.

LITTON INDUSTRIES
Components Division

A DIVISION OF LITTON INDUSTRIES, INC.

LITTON PRECISION COMPONENTS: Potentiometers • Ferrite Isolators • Rotary Joints
USECO ELECTRONIC HARDWARE: Hardware & Terminals • Terminal Boards • Printed Circuits

NEW!

GREATER...

- **OUTPUT**
- **STABILITY**
- **ACCURACY**

- Multi-column
- Smaller size
- Hermetically sealed

Cox and Stevens

LOAD CELLS

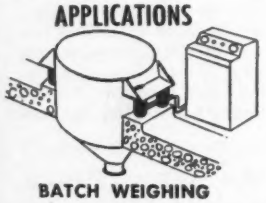
For greater accuracy and stability in all types of weight and force measurement, specify new Cox and Stevens hermetically sealed load cells. Sixteen strain gages in multi-column design provide up to 250% greater output, improved stability and better uniformity between cells. Capacities range from 500 to 200,000 lbs. All cells with 30 feet of special moisture- and chemical-resistant cable in stainless steel jacket.

Cox and Stevens' fifteen years experience in designing and manufacturing load cells, plus dead weight testing facilities which make possible calibration to higher accuracies, assure maximum reliability. Write for technical bulletins.

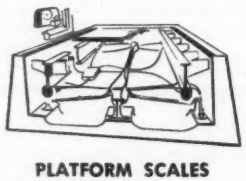
TYPICAL SPECIFICATIONS

1. Recommended Input:	20 volts
2. Change in Output, No Load to Full Load:	1.750 ± .1% millivolts/volt input
3. No Load Output:	± .25% of full load output
4. Output Linearity:	0 to + .20% of full load output
5. Temperature Effect on Cell Output (15 to 115°F):	± .0008%/°F of output at applied load
6. Temperature Effect on No Load Output (15 to 115°F):	± .0013%/°F of full load output
7. Input Impedance at 75°F:	450 ± 1 ohms
8. Allowable Load:	225% of rated capacity
9. Deflection Under Rated Load:	Less than 0.003"

APPLICATIONS



BATCH WEIGHING



PLATFORM SCALES

MISSILE WEIGHING

also Continuous Weighing · Proportioning · Truck, Track, Tank and Crane Scales · Thrust Measurement

53

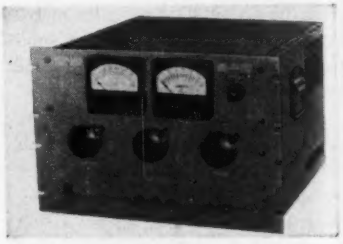
REVERE CORPORATION OF AMERICA

Wallingford, Connecticut

A SUBSIDIARY OF NEPTUNE METER COMPANY

neptune

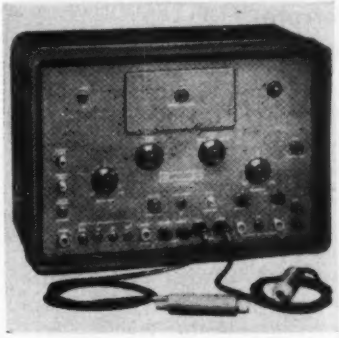
tailing by 75 percent by eliminating the tedious wire preparations formerly required. **Circle 435 on Reader Service Card.**



Voltage Adjuster and stepper

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N. Y., announces release of a new line voltage adjuster and stepper designed to vary the input voltage for testing the performance of electrical and electronic equipment. Model 920 B provides for adjusting and stepping the line voltage from 95 to 135 v a-c for any fixed input voltage in the 95 to 135 v a-c range.

Output capacity is 3.5 kva for input line voltage above 114 v. This output capacity decreases linearly to 3 kva at an input line voltage of 95 v. The output step voltage can be adjusted from 0 to 40 v. **Circle 436 on Reader Service Card.**



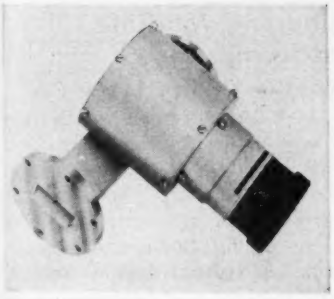
Sweep Generator covers 100 kc—20 mc

MARCONI INSTRUMENTS, 111 Cedar Lane, Englewood, N. J., announces a sweep generator covering 100 kc to 20 mc with crystal markers throughout this range. Manufacturer claims that the in-

strument, model 1099, enables response measurements to be made with a discrimination of at least 0.01 db.

Output level (3 v maximum) is stabilized and the instrument is supplied with detector probes on both input and output. With these probes a greatly amplified indication can be obtained of the deviation of an amplifier frequency response from level, and measurements are largely independent of input level changes.

An instrument of this accuracy finds ready application in design and checking of filters and video circuits. **Circle 437 on Reader Service Card.**

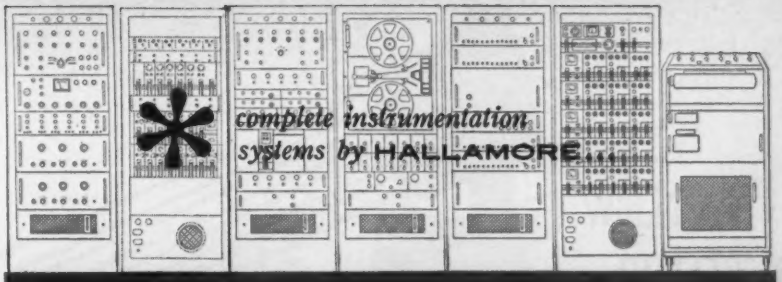


Frequency Meter direct-reading unit

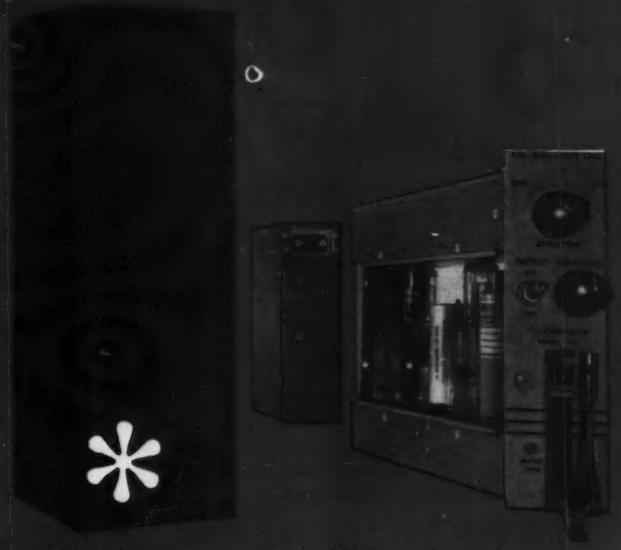
POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. Type 590-A direct-reading frequency meter allows quick determination and easy reading of frequencies in waveguide systems operating between 5,100 and 5,900 mc. It is available for general use as a separate unit, or it may be installed as a permanent part of another piece of equipment.

The 590-A consists of a TE_{on} mode cavity resonator tuned by a non-contacting plunger whose position is variable along the axis of the cavity. The calibration spiralled around a drum dial indicates frequency directly in mc. The cavity is coupled to a section of waveguide fitted at both ends with cover flanges, enabling the units to be inserted directly into any line of matching waveguide size.

A four-ft scale is attained through spiral calibration of the drum dial, with careful control of



A NEW CONCEPT IN VOLTAGE CONTROLLED OSCILLATORS



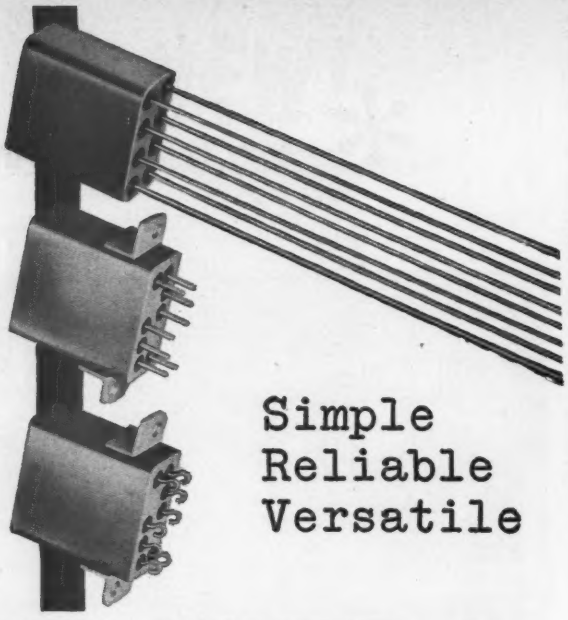
*module size 2" x 7¾"... adjustable internal bias... all standard IRIG channels...*The voltage controlled subcarrier oscillator, shown in this building block type FM instrumentation system, is the latest in a series of building-block components developed by Hallamore Electronics Company for the instrumentation field. Engineered for stability and flexibility, the unit designated HEC-0161 is entirely compatible with existing systems and offers unusual advantages in improved accuracy, operational simplicity, and the saving of space. A standard module case will accommodate up to six oscillators and a summing amplifier, HEC-0166. A common supply, HEC-0144, integral to the module case, provides the power in this configuration, while an individual supply, HEC-0143, is available to provide complete isolation for each transducer input.

The basic Hallamore voltage controlled subcarrier oscillator unit, HEC-0161, can be instantly converted to any IRIG telemetering channel by plug-in channel selectors, HEC-0164, and output filters, HEC-0165. Plug-in units for non-standard channels and bandwidths can be supplied. For complete specifications and operational data, write Hallamore Electronics Company, Dept. 88, 8352 Brookhurst Avenue, Anaheim, Calif.

HALLAMORE ELECTRONICS COMPANY *a division of the SIEGLER CORPORATION*

NEW LIGHT-WEIGHT

Micro-miniature Relay



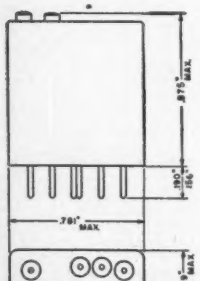
Simple Reliable Versatile

HUSKY STYLE 6

Price Electric's new Style 6 micro-miniature relay is a lightweight, crystal can style relay designed to give superior performance in miniaturized assemblies.

Weighing only 0.5 ounce, the Husky Style 6 is engineered for the utmost simplicity—a simplicity that allows for mass production of a high quality, reliable relay that is as versatile as it is dependable. Termination can be provided to meet most requirements. Style 6 meets the applicable requirements of military specifications and will perform continuously in ambients of −65C to +125C. This tiny Husky Relay will give excellent performance in guided missiles, computers, control systems, and other critical applications.

For further details write for Bulletin Number 10.



SPECIFICATIONS

Ambient Temperature: —65C to 125C.
Coil Data—Supplied with 920 ohms ±10% for 26.5 VDC nominal operation. Coils, with different resistance values, are available for other voltages.
Contact Arrangement—DPDT
Contact Rating—2 amps. at 26.5 VDC or 115 VAC resistive.
Contact Resistance—0.05 ohms max.
Dielectric Strength—1,000 volts RMS to case, 500 volts RMS across open contacts.
Enclosure—Hermetically sealed.
Insulation Resistance—10,000 megohms minimum at 25C. 1,000 megohms minimum at 125C.
Life—Minimum expectancy 100,000 operations.
Military Specifications—Meets applicable portions of MIL-R-25018 and MIL-R-5757C.
Mounting—All popular types or styles available.
Operate and Release Times—5 millisecond maximum.
Shock—50 G for 11 milliseconds.
Terminals—Plug-in, solder and printed circuit types.
Vibration—10 to 55 cps at 0.120" double amplitude. 55 to 2,000 cps at 20 G acceleration.
Weight—0.5 oz.

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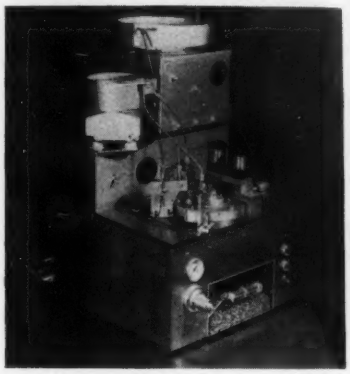
At Booth No. 2407
I.R.E. Show
March 24-27

PRICE ELECTRIC CORP. FREDERICK, MD. HUSKY RELAYS, CONTROLS ®

Price Electric CORPORATION

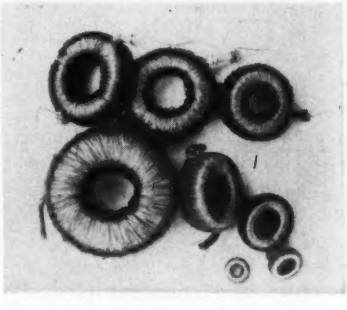
1500 Church St., Frederick, Maryland

critical dimensions for low-cost accuracy. Unusually high resolution is provided because the extra-long scale covers a range of only 800 mc. **Circle 438 on Reader Service Card.**



Capping Machine automatic unit

STREMPEL INSTRUMENT CORP., Lake George, N. Y., has available a new automatic capping machine that automatically feeds and assembles rod shaped bodies and press-fit caps at a rate of 4,000 pieces per hr. Bodies and caps are bulk loaded into vibratory feeders. The machine also incorporates an automatic shut-off which stops the drive when either caps or bodies fail to feed. The drive and cycle timing are electrical. Capping operation is pneumatic. **Circle 439 on Reader Service Card.**



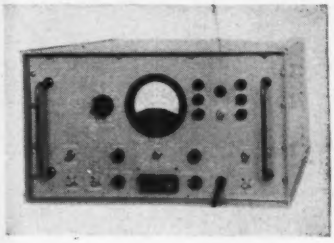
Toroids high tolerance

BARKER & WILLIAMSON, INC., Canal St. & Beaver Dam Rd., Bristol, Pa. Of interest to manufacturers of memory devices, chokes, filters, transformers and other components utilizing toroids, are a new

line of specials, wound on high-permeability cores.

Sizes range from $\frac{7}{8}$ in. to 3 in. o-d with frequencies from 1,000 cps to 200 kc. They are available with inductance and Q values to specification. The manufacturer claims a high degree of stability vs voltage and temperature, and they can be designed to compensate for extreme variations in temperature.

Tolerances are said to range from 5 percent to 1 percent for special requirements, and finishes may be plain, waxed, potted encapsulated or hermetically sealed to meet MIL-T-27A. **Circle 440 on Reader Service Card.**

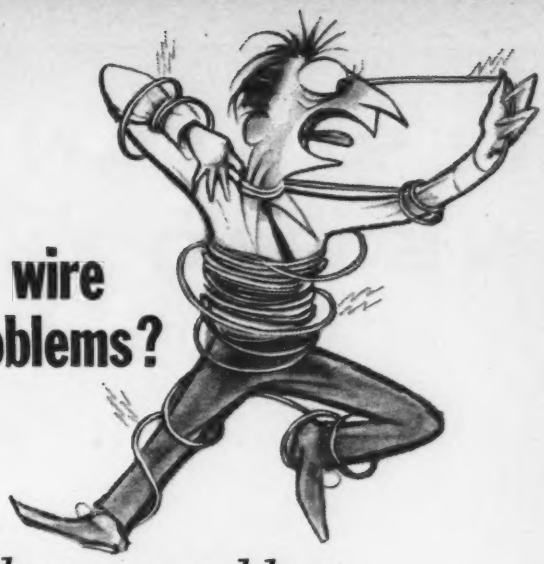


Phase Angle Meter and monitor

CONTROL ELECTRONICS CO., INC., Huntington Station, N. Y., has developed a phase angle meter and monitor that provides direct reading without ambiguity, together with high accuracy over a wide frequency and amplitude range.

The rugged equipment provides accurate and rapid measurement of phase difference, no matching of amplitudes or wave forms being required. It offers direct reading 0 to 360 deg with accuracy ±1 deg, 20 to 20,000 cps, and makes possible continuous, unattended monitoring of phase angle by use of chart recorder.

Model 120 is offered for use in the testing and inspection of servo amplifiers, feedback amplifiers, audio and power transformers, resolvers, goniometers, synchros and polyphase systems. It accepts sinusoidal or complex wave forms and an output is available which is suitable for use with recording equipment. Weighing 59 lb, its dimensions are 11½ by 20 by 18 in. deep and it can be mounted in a



Use the no-problem

INSO *Teflon® Insulated*
wire and cable

PROBLEM:

solved by INSO

PINHOLES: *No pinholes in any length of Inso wire.*

SHORT LENGTHS: *Inso can deliver continuous lengths up to 2,000 feet with no breaks, no splices.*

SPACE: *Inso gives you as much as 100% space advantage.*

WEIGHT: *Inso gives you as much as 35% weight saving.*

DRESSING: *Shape Inso once and it stays put — any position, any form.*

CONCENTRICITY: *Inso's "fused film" Teflon insulation is perfectly concentric, always even — the conductor doesn't "wander."*

ENCAPSULATION: *Inso's special Teflon insulation can be encapsulated with no reduction in dielectric strength, no discoloring.*

CODE IMPRINTING: *Inso will take any cold or hot stamping process.*

. . . And our precision-fusing process insures the constant quality of Inso Teflon insulated wire.

Electrical Testing Laboratories, Inc. Report 367495 certifies that Inso 4 mil wall wire passes all MIL spec. tests for conventional 8 to 12 mil wall Type "E" wire.

In production — Immediate delivery — All colors, solid and striped

- **8 mil wall Type "E" (MIL W-16878-B) . . . passes ALL spec. requirements.** *600 volt RMS, 2.0 KV*
- **6 mil wall Type "E" (MIL W-16878-B) . . . passes ALL spec. requirements (with a thinner wall).** *600 volt RMS, 2.0 KV*
- **4 mil wall Type "E" (MIL W-16878-B) . . . passes ALL spec. requirements (with the thinnest wall).** *600 volt RMS, 2.0 KV*
- **Pinhole-free MAGNET WIRE — exceeds MIL A-19583 — 4, 6 & 8 mil wall.**

®DUPONT

Please write, wire or call us today for samples and technical data.

INSO PRODUCTS, LTD.

A Subsidiary of Adam Consolidated Industries, Inc.

404 Fifth Avenue, New York 18, N.Y. Wisconsin 7-4700

Plant: Union, N.J. Cable Address: "INSULATION NEW YORK"

See Us at the IRE Show, Booth 4054

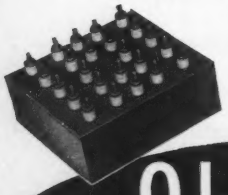
RESISTANCE NETWORKS

Maintain Precise Voltage/Current Ratios

In missiles, computers, instruments . . . in ac or dc circuits . . . wherever voltage or current must be adjusted within close limits . . . Shallcross Networks provide accuracy and dependability.

FROM A RELIABILITY STANDPOINT, use of sealed networks is recommended in preference to individual resistors to eliminate harmful preventive maintenance. In field servicing the technician is often not aware of the precise T.C. and reactance matching of otherwise seemingly ordinary MIL resistors. In addition to special winding techniques the individual resistors in critical networks are usually stabilized. Replacement of any resistor with a standard MIL type could cause equipment malfunction, and must be prevented.

FROM A DESIGN STANDPOINT Shallcross' skill and ability assure adherence to the most exacting temperature, stability, shock, size, and weight requirements. Shallcross precision engineered networks have proven effective both in ground-based and airborne equipment.
Two typical Shallcross resistance networks are described below. Many others with specialized electrical and mechanical characteristics are regularly manufactured.



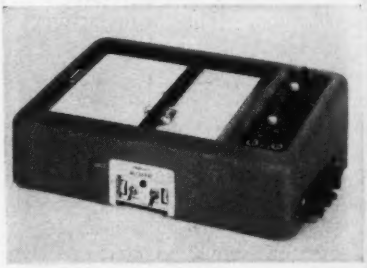
SECONDARY-STANDARD VOLTAGE REFERENCE SOURCE is built around this 24 terminal Shallcross resistance network. Using an oil-filled enclosed network of 21 matched T.C. resistors with stabilities of 0.001%, the instrument maintains an absolute accuracy of 0.01% from 0° to 50°C.

Shallcross

GROUND-SUPPORT COMPUTERS employ a number of these hermetically-sealed, standard, octal, plug-in networks. Networks have up to 10 specially wound resistors which are critically located and lead-dressed to meet specifications at 400 cycles. All units are production tested for voltage division accuracy and quadrature error using a precise 400 cycle bridge.

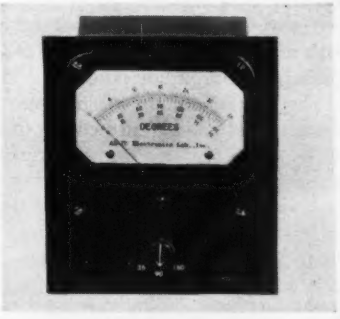
SHALLCROSS MANUFACTURING COMPANY • 522 Pusey Ave., Collingdale, Pa.
SEE US AT THE I.R.E. SHOW—BOOTH 2634

standard 19 in. rack when the cover is removed. **Circle 441 on Reader Service Card.**



X-Y Recorder with time base

F. L. MOSELEY Co., 409 North Fair Oaks Ave., Pasadena, Calif., announces the model 3S Autograf X-Y recorder with built-in time base or sweep circuit on the x-y axis. It will plot versus time any physical or mechanical function which can be reduced to electrical form. Available at finger-tip control are five calibrated time intervals of from 5 sec to 500 sec for full scale x-axis pen travel. When the time base is not used, regular two-variable plotting may be accomplished as desired. **Circle 442 on Reader Service Card.**

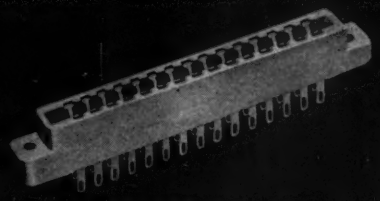


Panel Mount Meter measures phase angle

AD-YU ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic, N. J. Type 410 panel mount phase meter has the following features: (1) No electron tube, battery or power supply. (2) No error due to harmonic or noise content. (3) No amplitude adjustment, no zeroing; direct reading in degrees. (4)

In printed card receptacles

The best is even better!

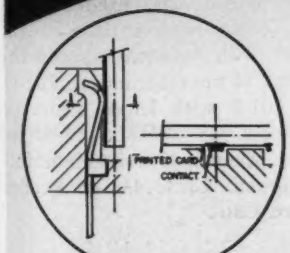


New UPCR-D Series

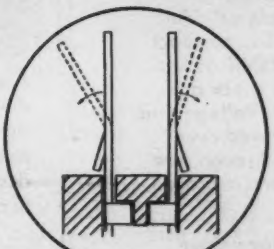
double row printed card receptacle

IMPROVED 4 WAYS!

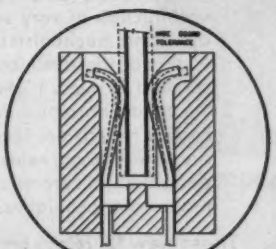
It is part of U.S. COMPONENTS' research and development policy never to be satisfied always on the alert for new ideas, materials, methods . . . and you are the benefactor. The new improved UPCR-D Series receptacles is an excellent example of the company's continuous progress in the field. Here is a foolproof precision connector series incorporating a number of new features, the result of a close liaison between application engineers and U.S. COMPONENTS. The proof is in the performance . . . write for sample and details! These new features are incorporated in over 150 types now available, meeting environmental requirements.



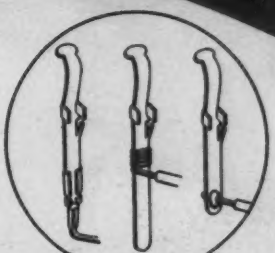
1. NEW CONTACT DESIGN, scientifically curved for minimum abrasion during repeated card insertion.



2. CONTROLLED TERMINAL HARDNESS, heat-treated beryllium copper permits flexibility in crucial areas maintaining maximum strength and no-creep.



3. WIDE BOARD TOLERANCE RANGE, controlled and repeated insertion and retention forces are assured over card range thickness of .062 or .093 of +.010.



4. PRECISION CONTACTS, wire-solder, taper tab (amp 78), and wire-wrap versions. Government approved processing—silver and gold plated.

USC

U. S. COMPONENTS, INC.

Associated with U. S. Tool & Mfg. Co., Inc.

454-462 East 148th Street, New York 55, N. Y. CYpress 2-6525

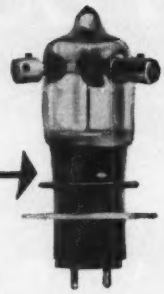
CABLE ADDRESS: Components N.Y. WUX RYU

SEE US at the I.R.E. SHOW—BOOTH 2706

JENNINGS PRESENTS

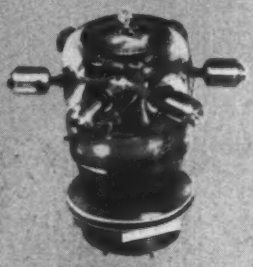
NEW RB VACUUM RELAYS

"Better performance in a smaller package"



New SPDT RB1
Only 2½" High

2PDT RB3



2PDT RB2

4PDT RB4

An all new series of vacuum relays designed for use where space is critical and voltages high.

Jennings vacuum transfer relays have long been unsurpassed in difficult rf and dc switching situations involving aircraft antennae, antennae tuning coils, and radar pulse forming networks. The minimum space requirements of these new miniature relays make them even more effective than previous vacuum relays for airborne applications.

High voltage in a vacuum requires only 1/64 inch contact separation. This fractional movement permits construction of very small, efficient actuating mechanisms. The compact design of these miniature relays has resulted in much higher shock and vibration characteristics. Voltage and current ratings are increased over previous vacuum relays through new design use of ceramics and improved processing techniques.

These new RB relays employ unique self-aligning roller contacts to achieve positive, reliable operation. Available contact arrangements include SPDT, 2PDT or 4PDT relays.

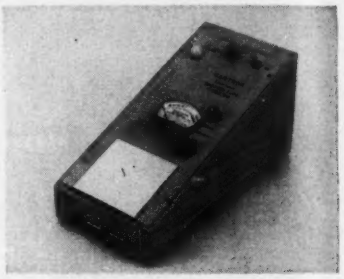
Jennings RADIO
VACUUM ELECTRONIC COMPONENTS

Write for further information on this new series.

JENNINGS RADIO MANUFACTURING CORP. · 970 McLAUGHLIN AVE. P.O. BOX 1278 · SAN JOSE 8, CALIF.

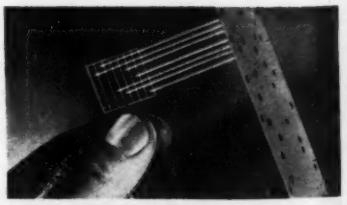
No drift, no warm-up period required; perfect stability. (5) High accuracy, ±2.5 percent. (6) Small physical size, 4¼ in. by 5¾ in.; weight less than 3 lb. (7) No ambiguity; meter indicates E_1 lead E_2.

The device is very suitable for measuring phase angle between two periodic potentials of any shape, sinusoidal or nonsinusoidal, regardless of the relations between the peak values. Phase ranges are 0-36 deg, 0-90 deg, and 0-180 deg. **Circle 443 on Reader Service Card.**



Coil Checker shows shorted turns

KARTRON, P. O. Box 472, Huntington Beach, Calif. Model 101-G for microminiature coils is the latest version of the shorted turn indicator. It checks unmounted electrical coils with inside dimensions down to less than 1/16 in. square with sensitivity approaching that of the other models 101-D and 101-E with larger mandrels, or probes. It will not check toroids. Manual 43 contains a full description. **Circle 444 on Reader Service Card.**



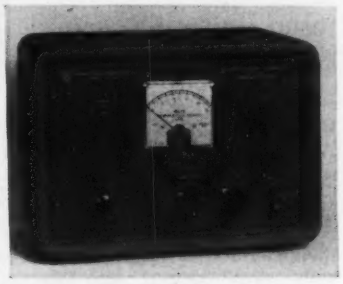
Photovoltaic Cells silicon devices

HOFFMAN ELECTRONICS CORP. Semiconductor Division, 930 Pitner Ave., Evanston, Ill. A new series of silicon photovoltaic cells have a

response time of less than 20 μsec, and a lifetime expectancy of over 10,000 years. They are particularly suitable for photoelectric devices requiring extremely fast response, dependability, maximum light sensitivity and low-cost.

The silicon cells, which are self-generating, require no external power supply. Their compact size allows for a greater number of control circuits than previously possible, where space is at a minimum.

The cells operate effectively through temperature variations from −65 C to +175 C and higher, with a spectral response range from 3,000 to over 10,000 Angstroms. Applications include punched tape and card readouts; programming controls; pinhole detection; remote switching controls; infrared sensing; automatic counting; heat, flame and hot-metal detection. **Circle 445 on Reader Service Card.**



Signal Generator standard frequency

AD-YU ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic, N. J. Type 209 standard frequency signal generator has an accuracy of ± 0.005 percent. The instrument consists of a tuning fork oscillator, with negative feedback for amplitude stabilization; a twin-T filter with a cascode amplifier for elimination of harmonic distortion; an output cathode follower; a resistive attenuator with 2,500 ohms impedance; an output meter circuit to indicate the signal voltage at the output terminals; and a regulated power supply.

In conjunction with a power amplifier, such as the type 230, this instrument may become a valuable

LATEST BALLANTINE VOLTMETER SETS NEW STANDARDS OF STABILITY, RELIABILITY, EXTENDED LIFE!

FEATURES

- **Long Life**
- **Outstanding stability**
- **High input impedance**
- **Wide voltage range**
- **Large easy to read meter with overlap**
- **High accuracy at any point on the scale**
- **Light, compact, rugged**

MODEL 300-D
PRICE: $235.

SPECIFICATIONS

VOLTAGE RANGE: 1 millivolt to 1000 volts rms. in 6 decade ranges. (.01, .1, 1, 10, 100 and 1,000 volts full scale).

FREQUENCY RANGE: 10 to 250,000 cps.

ACCURACY: 2% throughout voltage and frequency ranges and ***at all points on the meter scale.***

INPUT IMPEDANCE: 2 megohms shunted by 15 μμf except 25 μμf on lowest range.

DECIBEL RANGE: −60 to +60 decibels referred to 1 volt.

STABILITY: Less than ½% change with power supply voltage variation from 105 to 125 volts.

SCALES: Logarithmic voltage scale reading from 1 to 10 with 10% overlap at both ends; auxiliary linear scale in decibels from 0 to 20.

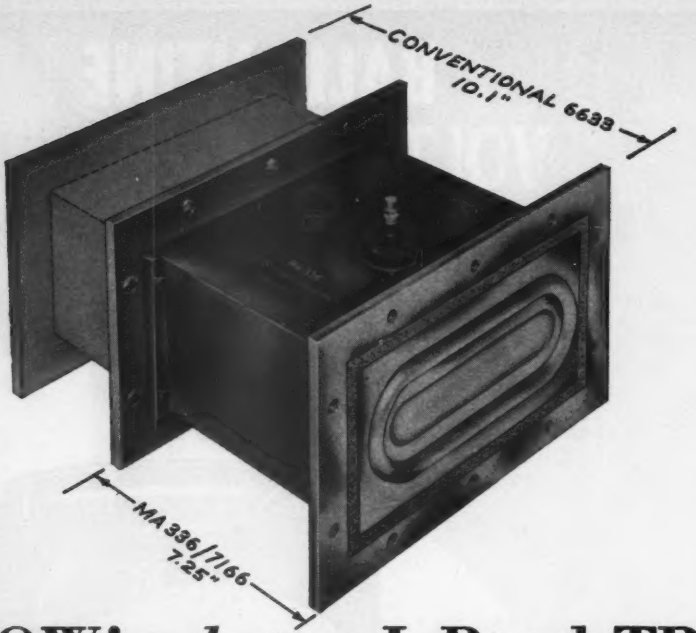
AMPLIFIER CHARACTERISTICS: Maximum voltage gain of 60 DB; maximum output 10 volts; output impedance is 300 ohms. Frequency response flat within 1 DB from 10 to 250,000 cps.

POWER SUPPLY: 115/230 volts, 50-420 cps, 35 watts approx.

Write for catalog for complete information.

BALLANTINE LABORATORIES, INC.

100 FANNY ROAD, BOONTON, NEW JERSEY



NOW! a *better* L-Band TR in a *smaller* package

Crystal protection guaranteed over 500 hour minimum tube life at full rated power in Microwave Associates new TR!

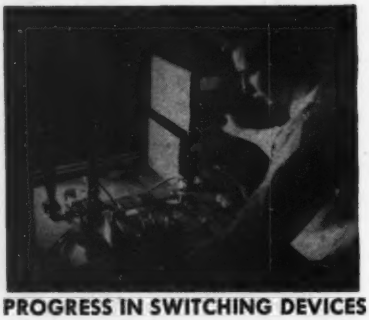
NEW, FIELD-TESTED DESIGN

Designed specifically to overcome the field deficiencies of conventional 6633 tubes, the MA 336/7166 offers substantially improved performance in all characteristics. See comparison chart below.

Several hundred of these tubes have been in the field for many months and are used in early warning systems operating 24 hours a day.

The first failure has yet to be reported either from the field or from monthly production life tests!

The MA 336 is a compact, rugged tube built for maximum reliability and completely guaranteed for performance. *It is in full production and available now.*



PROGRESS IN SWITCHING DEVICES

Microwave Associates' special switching devices group under the direction of Dr. Lawrence Gould is making steady advances in the art. Available right now are high performance tubes of advanced design: high power single and dual pre-TR tubes; low level receiver protector tubes and high power ATR tubes.

If you are interested in switching high powers and in guaranteed crystal protection at any frequency write or call for full information

COMPARISON CHART

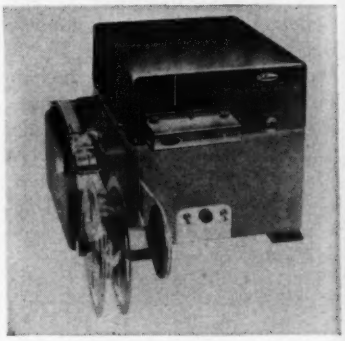
	MA 336/7166	Conventional #6633
Crystal protection	Guaranteed for 500 hrs. min. at full rated power: 2 megawatt peak	Not guaranteed
Recovery time	Short . . . less than 25μ seconds	Long 45μ seconds
Low level characteristics	VSWR 1.3 max. over full band. Insertion loss: 0.5 db (.7 db at end of life.)	VSWR 1.4 max. Insertion loss: 0.7 db (1.0 db at end of life.)
Size	7.25" long	10.1" long

MICROWAVE ASSOCIATES INC.

BURLINGTON, MASSACHUSETTS • Telephone BRowning 2-3000

precision frequency power source for testing servo components.

The standard frequency is 400 cps; other frequencies can be supplied on request. Output voltage range is 0 to 10 v continuously variable. An output meter is supplied for direct indication of a signal voltage at output terminal on panel meter in rms value, with an accuracy of ± 3 percent. Output impedance is 2,500 ohms. Distortion is less than 0.5 percent. **Circle 446 on Reader Service Card.**



Input Unit for tape punch

Coleman Engineering Co., Inc., 6040 West Jefferson Blvd., Los Angeles 16, Calif. A compact tape punch input unit recently developed by Coleman mounts directly on a motorized tape punch manufactured by Commercial Controls. The integral unit accepts digital input data, programs the desired format, and scans the digital information into the tape punch.

Designated model CCV-40, the new tape punch input unit features a patching program plug to permit format changes to be made easily, capacity up to 40 information bits (digits, command symbols, etc.), and a diode matrix to provide any desired code up to 8 channels.

The unit is also available for rack panel mounting. **Circle 447 on Reader Service Card.**

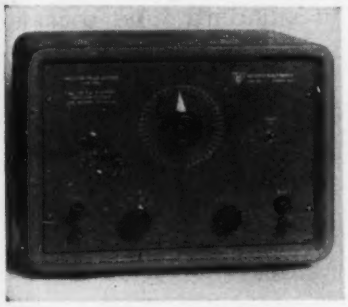
Solid Electrolytics with new ratings

Sprague Electric Co., 35 Marshall St., North Adams, Mass. Expansion of available ratings of

solid electrolyte Tantalex capacitors to include new ratings from 0.22 μf to 4.7 μf at 35 v d-c is announced. These new higher ratings are expected to find wide application on 28 v electronic equipment used in aircraft and missiles, both of electron tube and transistor circuit design.

Sprague has also added 20 v solid-electrolyte Tantalex electrolytic ratings from 0.22 μf to 15 μf to its standard line.

These new designs are of the sintered-anode type and complement the lower capacitance wire-anode types previously announced. **Circle 448 on Reader Service Card.**



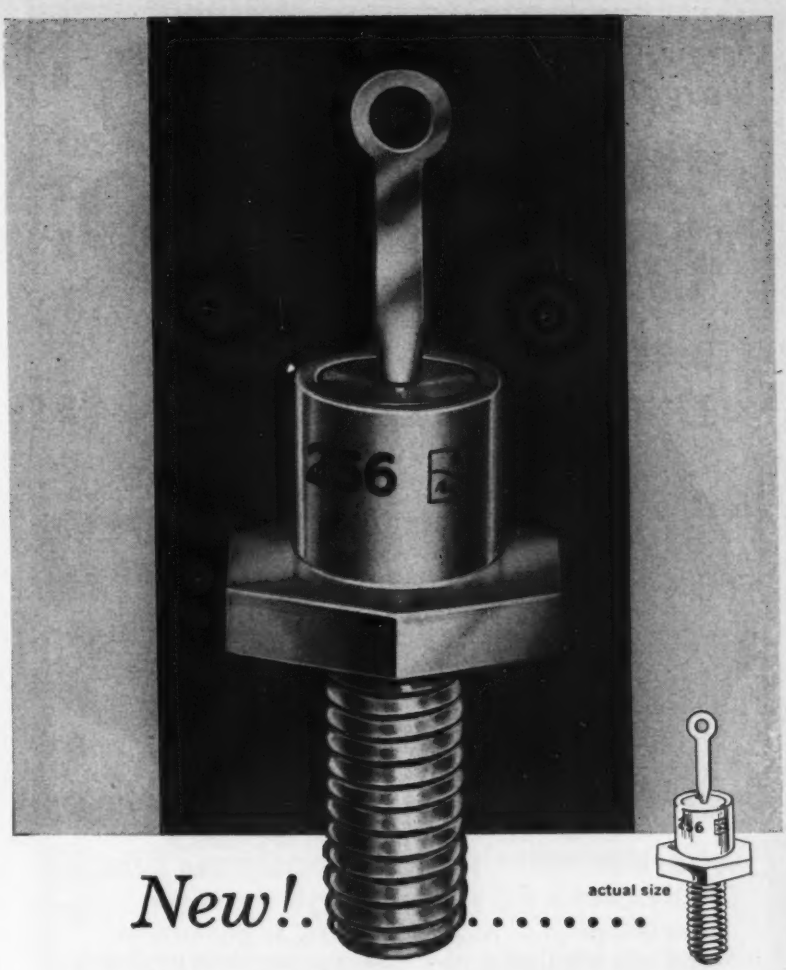
Phase Shifter with 0.1 deg accuracy

Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J. Type 208 precision phase shifter consists of resistant-capacitance phase shifter networks, an electron-tube phase inverter, and an output cathode follower.

The instrument is well adapted for precision measurement of phase angle between the output and input of an amplifier, filter, transformer, servo system, and any other four-terminal networks. It is also suitable for accurate calibration of phase measuring instruments, such as phase meters, phase shifters and others.

Phase range is 0 to 360 deg. Maximum error is less than 0.1 at 400 cps. Maximum input signal is 25 v rms. The frequency range for direct phase reading is 400 cps. With correction curve supplied with the instrument, the frequency range can be extended beyond this range.

The impedance looking into the

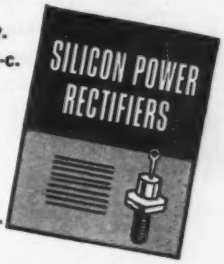


New!.....

SILICON POWER RECTIFIERS

53 TYPES including military 1N253, 1N254, 1N255 and 1N256

- 200 ma to 1 amp current capability.
- Voltage ratings from 50 to 1000 vd-c.
- Reliable operation at 150°C.



Send for bulletin 58R . . .

MICROWAVE ASSOCIATES INC.

Burlington, Massachusetts • BRowning 2-3000

Quiggle Quells the Query

...where to get the best bandpass filters?

Major Quiggle*, KC, AC, DC, MC, fixed his procurement manager with a withering stare. "So now our whole production line is held up," he barked, "while you try to find a good bandpass filter with a flat response between 17 and 20 kcs. And you also insist that it have sharp low and high frequency cut-off," he added.

The manager reeled with the outburst. Never had he seen the old man in such a fury over a simple question of where to get the best bandpass filters.

Quiggle continued, "Haven't you been reading the trade paper advertisements? Why don't you call Barker & Williamson! They've been making filters of all types such as Band Elimination, High-Pass and Low-Pass for years . . . must be experts on the subject, they'll have the answer."

And B&W did have the answer. The Model 360 torroidal bandpass filter was perfect. With a flat response between 17.2 and 20.2 kcs, Quiggle's engineers found many other favorable characteristics when they obtained a spec sheet on the unit by the simple expedient of calling B&W.

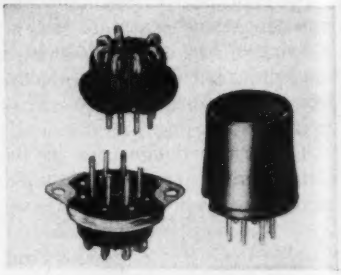
*Now a confirmed customer and friend, name is withheld intentionally

Barker & Williamson, Inc.

Beaver Road, Bristol, Penna.

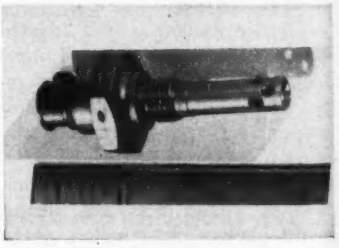
B&W also design and manufacture filters for: ANTENNAS • RADIO INTERFERENCE • RADIO RANGE • UHF and VHF as well as many special types designed to performance specifications. Available to commercial or military standards.

output terminals is 300 ohms nominal shunting resistance, and 2 μf series capacitor for d-c blocking. Input impedance is about 100 K in series with 2,000 $\mu\mu$f to ground. **Circle 449 on Reader Service Card.**



Molded Plugs fit standard tube sockets

METHODE MFG. CORP., 7447 W. Wilson Ave., Chicago 31, Ill. Seven and nine prong molded plugs which fit standard tube sockets now provide economical means for easily engaged multilead connections. Offering considerable space savings over the earlier octal and wafer type construction, plugs and mating sockets are available in both commercial materials and finishes and to the applicable requirements of JANS-28A. The connector pairs benefit from the high reliability and low cost inherent in high production vacuum tube socket terminals. **Circle 450 on Reader Service Card.**



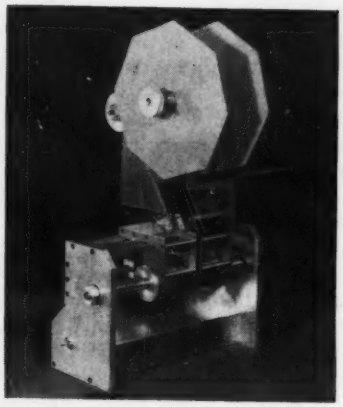
Transducer measures temperature

NACIMCO PRODUCTS, INC., National City, Calif. The instrument illustrated is a precision resistance thermometer type of temperature transducer utilizing deposited platinum film techniques. It has exceptional speed of response, and is

said to be 50 to 100 times faster than any temperature measuring instrument heretofore available.

The new temperature transducer is extremely rugged and has the ability to withstand extremes of both vibration and pressure. It has a base resistance up to 10,000 ohms, with ranges from − 370 deg to + 500 F. Sensing element of the instrument is $\frac{1}{8}$ in. in diameter and 0.030 in thickness.

This deposited film type unit is offered in a number of configurations. Primarily developed for missile use, it is being used at present by a number of major companies working on missiles. A wide range of potential applications for automation and instrumentation are being projected. **Circle 451 on Reader Service Card.**



Reel-Pack Feed and clip-bend

STREMPEL INSTRUMENT CORP., Lake George, N. Y., announces two new units: an automatic clip-bend machine and an automatic reel-pack feed mechanism (shown mounted on the clip-bend). The clip-bend machine cuts leads of axial lead parts and bends them at right angles for mounting in wiring boards.

It is fully adjustable and will accommodate all commonly used parts. Operating rate is 4,000 pieces per hr. Set-up time, changing all dimensions, is approximately 2 min. The automatic reel-pack feed mechanism will feed reel-packed parts to any machine. This simple feed senses the emptying of parts

New!

MINIATURE TIMERS

of Field-Proved PERFORMANCE by HAYDON* at TORRINGTON

FOR 115 VOLT, 400 CYCLE OPERATION

First to develop a truly miniature elapsed time indicator, HAYDON at Torrington now offers this varied line of miniature, hermetically sealed, timing devices . . . all tested and proved in the field in missile guidance and jet aircraft applications.

Basis of all these miniature devices is the Haydon 400 cps Synchronous Timing Motor . . . the inherently accurate approach to instrumentation in military equipment. Sealed-in-steel case eliminates stray magnetic fields. Elapsed Time Indicators are available in the direct-reading type illustrated and also in dial type. Newest additions to the line are the miniature Time Delay Timer and the miniature Repeat Cycle Timer available with 1 to 4 switches. Weight is approx. 7 ounces.

OTHER HAYDON TIMERS FOR MILITARY APPLICATIONS . . . include: D-C Timing Motors for 6 to 32 volt operation, 60 Cycle A-C Motors in a very wide range of speeds, Heavy Duty 400 Cycle Timing Motors, and Elapsed Time Indicators for 60 cycle operation.

GET COMPLETE INFORMATION NOW . . .

Consult the Haydon Field Engineer in your area or, if you prefer, write to us direct, outlining your requirements. You'll find that Haydon has the experience, know-how and facilities to solve all your timing problems.

*TRADEMARK REG. U.S. PATENT OFFICE

HAYDON AT TORRINGTON
HEADQUARTERS FOR TIMING

HAYDON

Division of General Time Corporation
2427 East Elm St., Torrington, Conn.

Twelve-and-a-half microvolt resolution at 20 readings per second! That's the outstanding feature of the analogue-to-digital converter, developed by Non-Linear Systems, Inc., Del Mar, California, to "digitalize" the output of low-voltage transducers in either ground or airborne service.

It's significant that Non-Linear Systems engineers selected thirteen miniature Bristol Syncroverter* high-speed relays (inset, top) for use in the converter scanning circuits. This versatile, high-speed, polarized relay has earned an enviable reputation for reliability, long life and immunity to shock and vibration in just such critical low-level, dry-circuit applications.

Are dry circuits your problem?

If so, we believe we have the answer. Dry-circuit reliability and long life are outstanding features of the Syncroverter high-speed relay. It's unaffected during severe shock and vibration. It has fast pull-in and drop-out and negligible contact resistance, and it operates reliably over a wide temperature range.

More than 20 models available

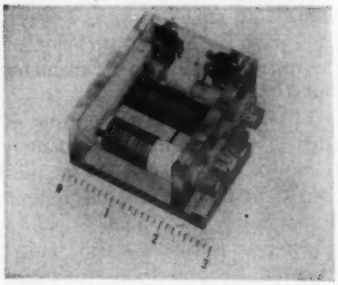
You can specify Bristol Syncroverter high-speed relays in an extremely wide variety of operating characteristics and in various case and mounting arrangements. Ask us for complete details. Write: The Bristol Company, 152 Bristol Road, Waterbury 20, Conn. 8.3A

*T. M. Reg. U. S. Pat. Off.

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER 68 YEARS

See our exhibit in Booth 3932 at the IRE Show

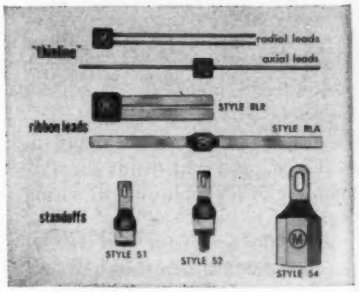
from its discharge chute and refills, keeping up with any demand rate to 10,000 parts per hour. It has a universal mounting suitable for use in any existing machinery. **Circle 452 on Reader Service Card.**



UHF Loading Coil for antenna testing

Alto Scientific Co., 855 Commercial St., Palo Alto, Calif. Model O-21 self-contained uhf loading coil for antenna testing comprises two concentric drums wound with plated copper ribbon wire. Inductance is varied through a common, spring-loaded gear drive with a positive mechanical stop at high and low ends. Provision is made for application at an external mechanical tuning drive.

Designed for operation at frequencies from 24 to 52 mc, the new coil permits inductance to be varied from 3 to 0.1 μh. Q is greater than 50 at 52 mc and greater than 225 at 24 mc. Power handling capability is 25w. **Circle 453 on Reader Service Card.**



Eight Ceramics for capacitor reliability

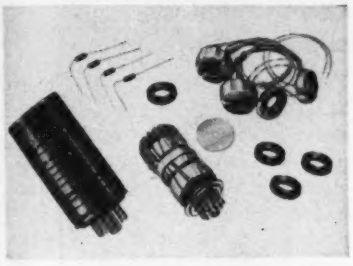
Mucon Corp., 9 St. Francis St., Newark 5, N. J. Subminiature ceramic capacitors are now availa-

ble in eight different ceramic materials to obtain the minimum size for the specific temperature characteristics required.

For example, a capacitor of 2.5 $\mu\mu$f measures $\frac{1}{4}$ in. square when made with NPO ceramic which has a zero temperature coefficient; at the other extreme, a $\frac{1}{8}$in. square capacitor made with Super-K ceramic measures 1,000 $\mu\mu$f but is usable only over a limited temperature range.

Various other ceramics give intermediate sizes and temperature characteristics.

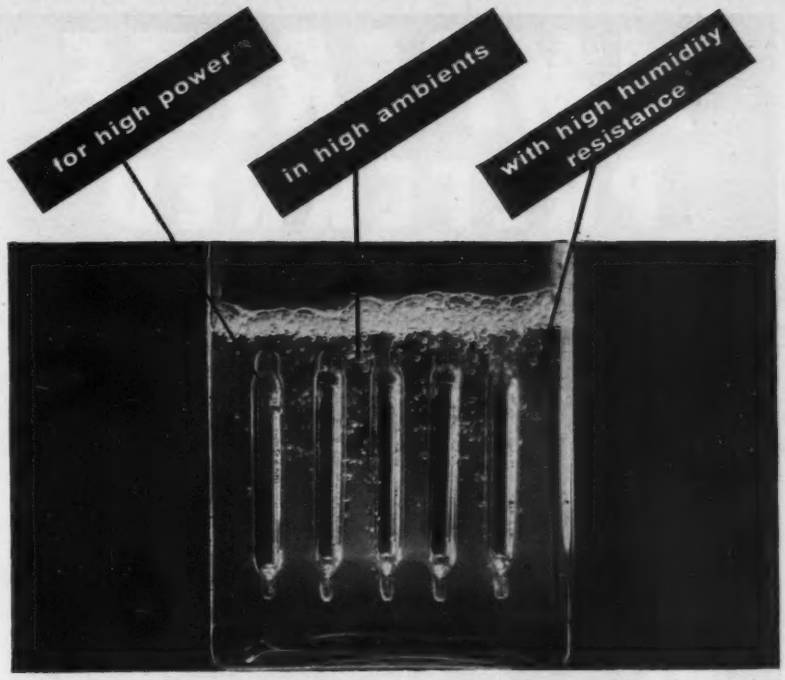
Thinline capacitors with radial or axial leads, ribbon lead units or standoffs are also available with each ceramic. **Circle 454 on Reader Service Card.**



Magnetic Amplifier. d-c to d-c

ACROMAG, INC., 22519 Telegraph Road, Detroit 41, Mich. Model 420 is a d-c to d-c magnetic amplifier especially designed for missiles, automatic pilots, helicopter rotor speed controls, jet engine fuel controls, and nuclear measuring and control equipments. It often replaces chopper-stabilized amplifiers where extreme bandwidth is not required.

Model 420 has a transimpedance, Z_m, of 50,000 ohms and delivers full linear d-c output from 10μw of d-c control signal; frequency response extends from d-c to 25 cps, depending on circuits used. It contains a push-pull, full-wave, reversible-polarity magnetic amplifier and uses negative feedback for stabilization and for improved linearity. Special power supplies, bias supplies, and balance controls are not needed. Model 420 uses less than 3 w of power and operates from standard 115 v



VICTOREEN ULTRA-STABLE FILM TYPE RESISTORS

Who ever heard of boiling water with resistors? Though they're obviously not designed for this purpose, Victoreen ultra-stable film type resistors *can* do it. What's more they stand up under this abuse.

The "boiling water test" does prove *conclusively* the high power . . . high humidity resistance . . . stable operation in high ambients—of Victoreen resistors. And you get all these desirable qualities in Victoreen *precision* resistors—Victoreen models RX-4 and RX-5.

	MODEL RX-4	MODEL RX-5
Resistance	200 ohms to 50 megohms	200 ohms to 200 megohms
Tolerance	1, 2, 5, 10%	1, 2, 5, 10%
Size	.413 dia. x 2" long	.413 dia. x 3⅛" long
Power	5W at 150°C 3W at 225°C	10W at 150°C 5W at 250°C

Stability—± 1% for 1000 hours guaranteed life at rated power

If you have an application requiring precision resistors for operation at high power with high stability in severe ambients, it will pay you to check with Victoreen first. AA-7088

Victoreen's Ultra-Stable Film Type Resistors will be on display at the IRE SHOW BOOTH 2232

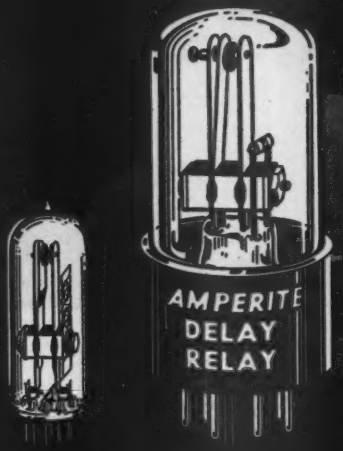
The Victoreen Instrument Company

Components Division

5806 Hough Avenue • Cleveland 3, Ohio

AMPERITE PREFERRED

by design engineers — because they're
MOST COMPACT • SIMPLEST • MOST ECONOMICAL
HERMETICALLY SEALED



Thermostatic DELAY RELAYS

2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are rugged, explosion-proof, long-lived, and—inexpensive!

TYPES: Standard Radio Octal, and 9-Pin Miniature. List Price, $4.00. Standard Delays.

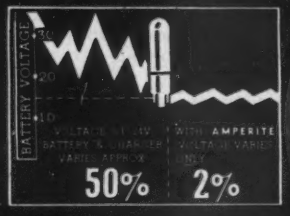
Also — Amperite Differential Relays: Used for automatic overload, under-voltage or under-current protection.

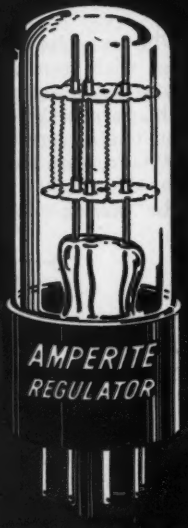
PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit automatically regulated at a definite value (for example, 0.5 amp.)

For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.





Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55° to +90° C.), or humidity. Rugged, light, compact, most inexpensive. List Price, $3.00.

Write for 4-page Technical Bulletin No. AB-51

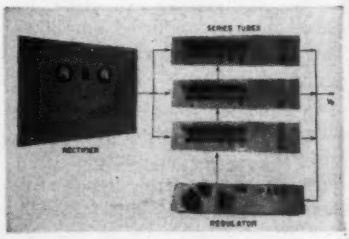
AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.
Telephone: CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

400 cps power. It is completely self-contained.

Distorted supply waveforms, 10 percent voltage and frequency variations, and temperatures from −55C to +85C do not impair performance. The unit is hermetically sealed and ruggedized in a steel case 1½ in. in diameter by 3 in. in height. Weight is less than 9 oz. **Circle 455 on Reader Service Card.**

Casting Powder speeds encapsulation

EPOXY PRODUCTS, INC., 137 Coit St., Irvington, N. J., has available the new Epoxy E-Form casting powder for the encapsulation of electronic components. It is a stable, dry blend of epoxy resin and hardener, in an easily handled, nontoxic powder form. Exhibiting all of the physical and electrical properties inherent in epoxy, the new powder offers the further advantage of liquefying and then hardening when heated. The powder was initially developed for use in conjunction with Epoxy E-Case shells. **Circle 456 on Reader Service Card.**

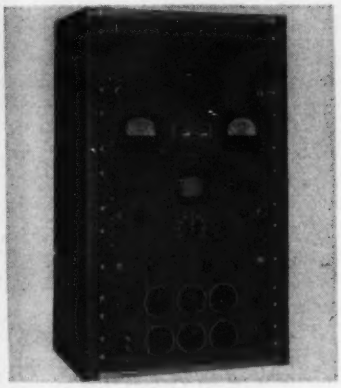


D-C Power Supply is modularized

DYNAMIC CONTROLS CO., 1955 Massachusetts Ave., Cambridge, Mass. Modular construction of regulated d-c supplies allows fast installation of a system. The supplies are sectionalized into three

basic panels for rack mounting: rectifier, regulator and series-tube. A single regulator controls any number of series-tube sections operating in parallel. The series-tube panels are conservatively rated at one ampere. The rectifiers come in three voltage ranges which in cooperation with the regulators give output voltages from 0 to 150, 150 to 300, and 300 to 500; current ratings are 1, 3, 6 and 10 amperes.

Expansion can be provided by paralleling series-tube sections and installing a larger rectifier or a parallel rectifier. Interchangeability reduces obsolescence. Output voltage performance is better than 0.1 percent for load and line changes, including transients. **Circle 457 on Reader Service Card.**



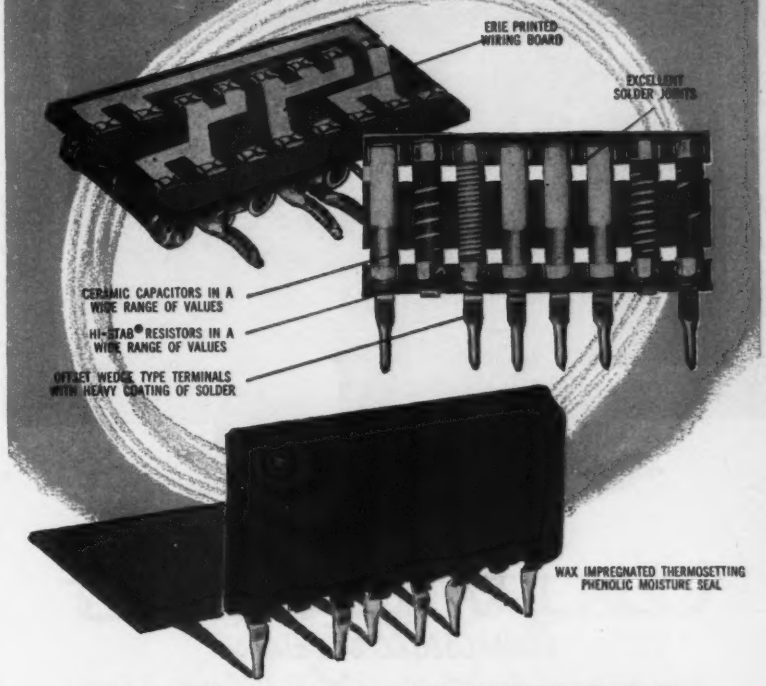
Impedance Bridge packaged system

PENNSYLVANIA TESTING LABORATORY INC., Doylestown, Pa. A completely packaged unit is offered as a standard system for measuring inductances with high-voltage a-c applied simultaneously with large d-c currents.

Type 277 is complete and provides for inductance measurements from 1 μh to 1000 henries with superimposed d-c currents as high as 4 amperes and a-c voltages up to 250 v from 20 cps to 20 kc. No auxiliary equipment is necessary. The bridge oscillator, power amplifier and d-c power supply are included as well as a sensitive null indicator which will indicate independently the real and quadrature components of the bridge balance points.

The bridge ratio arms will dissi-

NEW...NEW...NEW
HIGH STABILTY
ERIE "PAC"
MODULES
with PRECISION FILM RESISTORS


ERIE PRINTED WIRING BOARD
EXCELLENT SOLDER JOINTS
CERAMIC CAPACITORS IN A WIDE RANGE OF VALUES
HI-STAB® RESISTORS IN A WIDE RANGE OF VALUES
OFFSET WEDGE TYPE TERMINALS WITH HEAVY COATING OF SOLDER
WAX IMPREGNATED THERMOSETTING PHENOLIC MOISTURE SEAL

LESS THAN 0.07% AVERAGE CHANGE
AFTER 1000 HOUR EXTREME HUMIDITY TEST

ERIE "PAC"
...THE ONLY MODULE
THAT INCORPORATES
PRECISION RESISTOR
ELEMENTS IN
ITS BASIC DESIGN

Through the employment of ½ watt precision film resistors, ERIE has added to its line of "PAC" modules and greatly widened the field of effective "PAC" applications.

"PAC" Pre-Assembled Components have proven immensely popular with manufacturers of home and auto radios, TV sets, electronic organs, and other equipment.

The new "PAC" units incorporating deposited carbon resistors, are highly resistant to humidity, and offer high reliability for precision military and industrial applications. They have been thoroughly proven in severe humidity tests in which they withstood 1,000 hour exposure with an average change of less than 0.07% and maximum change of 0.19%.

Samples will be submitted for your own trial tests and applications.

ERIE Electronics Division
ERIE RESISTOR CORPORATION
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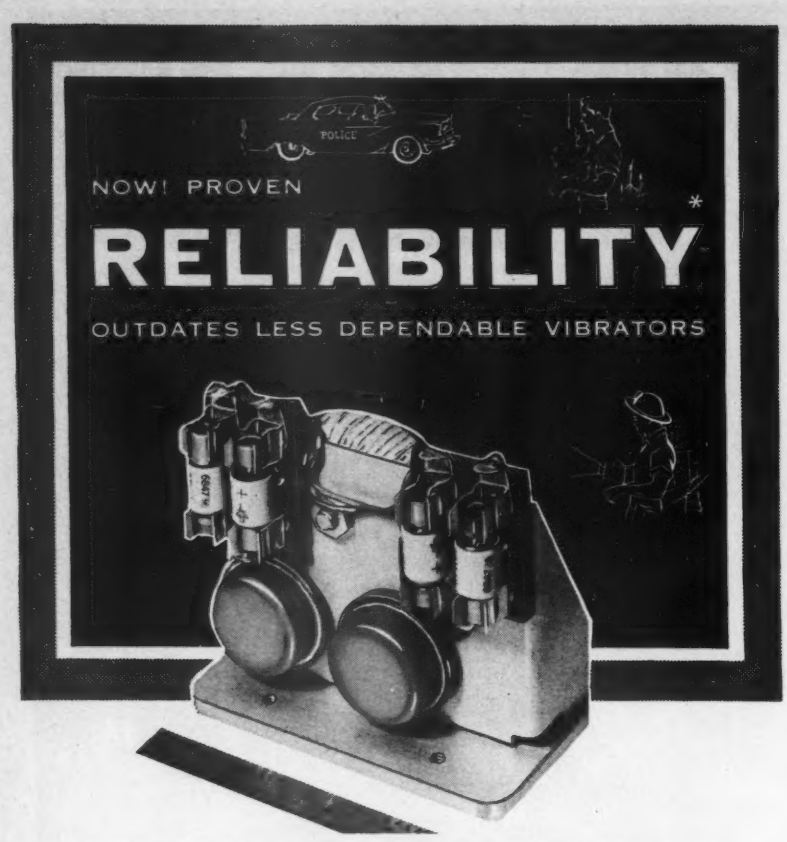
FACTORIES: ERIE, PA. • HOLLY SPRINGS, MISS. • TRENTON, ONTARIO, CANADA



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transistorized
DC-DC STATIC CONVERTERS

Compact, highly efficient Universal Transistorized Static Converters outlast conventional non-transistorized vibrator power supplies and similar mechanical equipment by thousands of hours. They convert DC voltage to higher DC voltage more efficiently in minimum-sized, lightweight packages. These features are particularly important where space is at a premium, as in two way radios and public address amplifiers.

Universal DC-DC Converters are complete units, fully transistorized, rectified and filtered. They require lower maintenance because there are no moving parts, no wear, no tear, no arcing.

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ONE COMPLETE SOURCE FOR QUALITY POWER SUPPLIES:
• DC-AC Inverters • AC to DC • DC to DC
• High Voltage • Low Voltage
• High Power • Low Power
• Custom units operate over Wide Temperature Ranges and Rugged Shock conditions.

*For leaders such as Bendix Radio, Dumont, General Electric, RCA, Sperry Products and Western Electric, UAC power supplies high transistor reliability (to 95% in 10,000 hrs. use). Low maintenance . . . minimum size and weight . . . long life . . . and efficiency as high as 98% . . . are paying important dividends. Whatever your power engineering problem, Universal has the unit to outlast and outperform conventional supplies by far.

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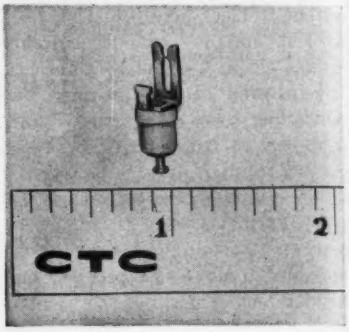
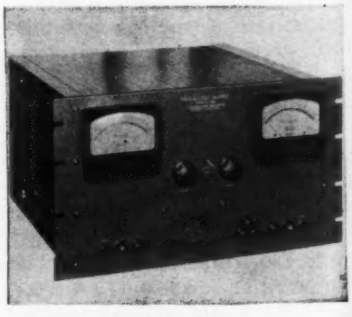
pate 500 w a-c and/or d-c and remain 0.1 percent accurate. Effective resistance within a billion to one range is also measurable as well as inductance. **Circle 458 on Reader Service Card.**



Diode Clip
for secure shock support

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., has developed a new insulated diode clip. It is fastened to a teflon insulator for a press fit mounting and is designed to securely support ferrule contact diodes under conditions of shock and vibration.

The clip (No. 2323), for mounting in hole diameter of 0.2055 in., can be used in chassis and panels up to $\frac{1}{8}$ in. thick. The construction provides solder points above and below panel. **Circle 459 on Reader Service Card.**



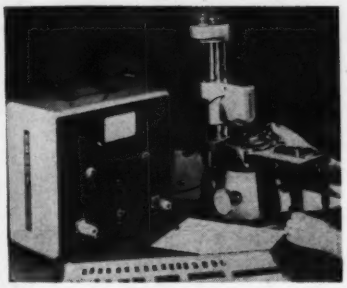
Power Supply
for transistor circuitry

DRESSEN-BARNES CORP., 250 North Vinedo Ave., Pasadena, Calif. Model 6-3MB is a closely regulated d-c power supply for powering

transistor circuits. Output is 0 to 60 v d-c, continuously variable, at 3 amperes maximum. No derating of output current, or of regulation and ripple specifications, is necessary from 1 to 60 v d-c.

Regulation for 60 v/3 ampere load is 20 mv change, no load to full load. For line voltage change of 105 to 125 v a-c (at 60 v/3 amperes output), regulation is 20 mv change in output voltage. Ripple and internal noise are below 1.5 mv rms. Unit is designed for very low output impedance and fast recovery time. One-percent meters are supplied.

The instrument is built to fit in a standard 19 in. relay rack. **Circle 460 on Reader Service Card.**



Comparator checks gage block size

THE SHEFFIELD CORP., Dayton 1, Ohio. One-millionth of an inch accuracy is obtained with a new electronic gage block comparator. The extreme accuracy of the new Dualjet comparator is based on the use of an opposed pair of transducer-type pick-up units.

Measurement is amplified either 100,000 or 10,000 times by an Accutron electronic amplifier. High magnification has a 0.000004-in. range and scale divisions of 0.000001 of an inch. A range switch permits instant change to low magnifications (10,000 to 1 with a 0.0004-in. range) without recalibration. The Accutron amplifier operates on 110-v, 50/60 cycle a-c. Compensation is provided for line voltage changes ranging from 95 to 125 v.

A precision ground, 40-pitch leadscrew on a steel column, rigidly mounted on the sturdy cast base, provides vertical coarse adjustment

UNIVERSAL
transistorized
DC TRANSFORMERS

Designers of much of today's important new electronic equipment for mobile, aircraft and marine applications specify Universal Transistorized DC Transformers because they are efficient, compact, rugged improvements on dynamotors. They reduce operating and maintenance costs because there are no moving parts, no wear, no tear, and no brush interference.

- FULLY TRANSISTORIZED
- RECTIFIED
- FILTERED
- Protect against short circuits, input polarity reversal, line and load surges available.

I.R.E. SHOW BOOTH 3937

PERFORMANCE CHARACTERISTICS
EFFICIENCY: As high as 98%
SIZE: As small as ¼ cu. in. per watt
WEIGHT: As light as ½ oz. per watt
INPUTS: 6-110VDC
OUTPUTS: to 2000 watts
REGULATION: to ±0.1%

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For Fast, Accurate Matching

of Resistors,

Capacitors, Inductors

SIE® **E-2 COMPARISON BRIDGE**

1 ohm to 5 megohms, 500 mmfd to 2,000 mfd, 3 millihenrys to 10,000 henrys.

- Five meter ranges: 1%, 2.5%, 5% 10% and 25% difference readings at full scale.
- Accurate within 0.1% on 1% scale.
- Component differences of 1 part in 10,000 can be detected.
- Can be used with decade box for precise component measurements.

$185.00

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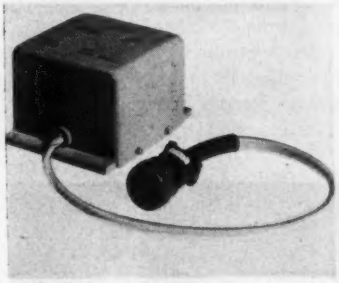
239-58

of the top gaging head. Fine adjustment is made with a cam and lever mechanism in the base with knobs that are completely isolated from gage head or anvil. The gage has interchangeable diamond points and a gage point lifting device to avoid scratching surfaces of work. Gaging pressure is 8 oz; vertical capacity, 4 in. A ratchet-type device raises or lowers the gage head in increments of 0.0005 in. **Circle 461 on Reader Service Card.**



Power Supply for mobile systems

AEROPHYSICS DEVELOPMENT CORP., P. O. Box 689, Santa Barbara, Calif. A transistor power supply designed for use on vehicles subject to high shock and vibration environments has been developed.

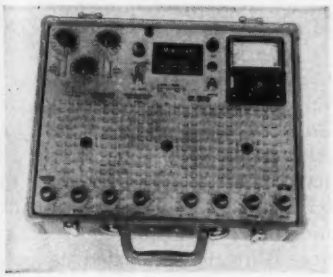
Designated TPS-5, the transistor operates in ambient temperatures from −40 F to +70 C, and converts 28 v d-c at 3 amperes to 225 v d-c at 300 ma for operating mobile electronic systems or devices. Package dimensions are 2½ in. by 3½ in. by 4½ in. including mounting flanges. The unit weighs 1.5 lb. **Circle 462 on Reader Service Card.**

Hook-up Wire permanently color coded

GENERAL CABLE CORP., 420 Lexington Ave., New York 17, N. Y. Spiracode is a new hook-up wire made by a modern, advanced technique of plastic extrusion which effects a permanent easy method of color coding hook-up wire that is actually colored plastic insulation solid to the conductor. This method of spiral plastic extrusion

permits a solid multi-colored plastic insulation spirally applied in barber-pole fashion of any combination of colors up to three on solid or stranded conductor.

The spiral stripes of solid colors on Spiracode are nonmigrating, nonfading, sharp, crisp, permanent brilliant colors that are readily identifiable and easily traced even in the most complicated wiring systems and harnesses. Both vinyl plastics and polyethylene insulations are available on this new hook-up wire. **Circle 463 on Reader Service Card.**



Breadboard for subminiature circuitry

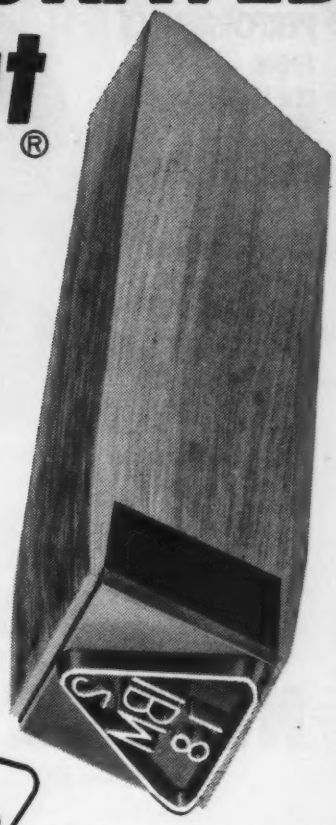
STANLEY AVIATION CORP., 2501 Dallas St., Denver 8, Colorado. The Mini-Lab illustrated provides a novel technique in electronic breadboarding for the rapid development, assembly, study and testing of circuits and components. It offers many new features not previously available to engineers: built-in multimeter; regulated power supplies; expendable plugs for component leads; short, direct connections; eight potentiometers; built-in resistance and capacitance selector boxes; convenience, portability, reliability.

Designed specifically for subminiature, miniature and semiconductor circuitry, Mini-Lab contains a grid of tiny jacks arranged in the form of tie points, voltage busses, ground busses, coupling junctions, and input and output terminals.

Miniature and subminiature tubes, transistors and other semiconductors may be quickly plugged into the board. Components such as resistors, capacitors, transformers, chokes and the like are plugged in

NEW! ENGRAVED Deep-Kut®

INSPECTION STAMPS are better than ordinary rubber 3 ways



ENGRAVED *Deep-Kut* IS ACID-PROOF

Acid etching inks, used for permanent stamping on metal and all non-porous surfaces will eat away at ordinary rubber. Deep-Kut resists this action—gives longer life by far!

ENGRAVED *Deep-Kut* STAMPING GIVES RAZOR-SHARP IMPRESSIONS EVERY TIME

Opaque inks will clog shallow rubber stamp faces rapidly. Our deep-molded engraved Deep-Kut stamp faces have more than three times the depth of ordinary rubber stamps. Markings always remain super sharp . . . an important advantage since this mark is a permanent record of your inspector's approval.

ENGRAVED *Deep-Kut* HAS CUSHION-LIKE RESILIENCE

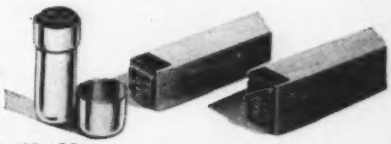
Our Deep-Kut molding process includes a timed curing that imparts to Deep-Kut all the elasticity of ordinary rubber. Resilient Deep-Kut resists abrasive action, conforms to irregular surfaces . . . and lasts much longer!

Engraved Deep-Kut stamp faces are adaptable to any marking device. They can be used to stamp on every surface, metal, wood, fabric, paper, plastic, etc.

VISIT OUR BOOTH No. 4011 AT THE I. R. E. SHOW
March 24-27 New York Coliseum

Some of the many industries now using ENGRAVED *Deep-Kut* STAMPS

AVIATION
ELECTRICAL
ELECTRONICS
PLASTICS
TEXTILES
PACKAGING



THE KRENGEL INSPECTION POCKET STAMP — THE PIN & PEG

KRENGEL MANUFACTURING CO., INC. *Tel. CO 7-5714*
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FREE ENGRAVED Deep-Kut Sample & Price List ☐
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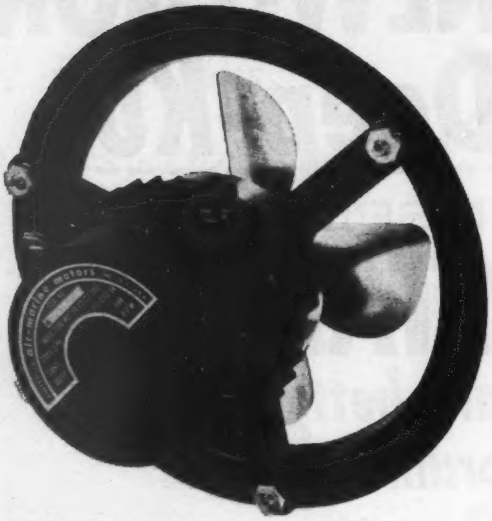
PROVEN PERFORMANCE FROM SEA LEVEL TO 70,000 FT

•

MAINTAINS CONSTANT COOLING EFFICIENCY



Mounting: 2½" across flats

NEW IMPROVED HIGH SLIP MOTORS DRIVE COOLING FANS AT VARYING ALTITUDES

New, improved, high-speed, high-slip motor design changes speed with lower densities (higher altitudes) to maintain constant cooling efficiency. These high-slip motors are rated at a minimum of 1,000 hrs. @ 125° C.; longer life expectancy at lower ambients. Choice of 400 cps or Variable at 1 ϕ, or 400 cps at 3 ϕ. Prototypes delivered in 2-6 weeks; Production deliveries 6-8 weeks. Circle card for data sheets and performance curves.

145 CFM at O"SP
at Sea Level
440 CFM at O"SP
at 70,000 ft.

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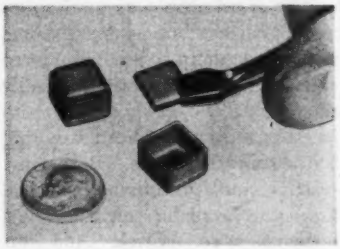
AIR-MARINE MOTORS, INC.

air·marine motors, inc.

AMITYVILLE, NEW YORK · LOS ANGELES, CALIF.

by means of expendable plugs easily crimped directly onto the leads. **Circle 464 on Reader Service Card.**



Shielding Capsules for miniaturized uses

MAGNETIC SHIELD DIVISION PERFECTION MICA CO., 1322 No. Elston Ave., Chicago 22, Ill., has developed a new line of subminiature Co-Netic magnetic shielding capsules designed for subminiature reactors and transformers used in transistorized and printed circuits and other miniaturized applications. Virtually eliminated are hum and noise caused by low level extraneous electromagnetic and electrostatic fields. Much closer grouping of components is now possible due to shielding effectiveness. When required, shields can be pretinned for soldering without affecting magnetic shielding qualities. Shielding capsules may be produced in a wide variety of shapes and dimensions using standard methods or special hydroform techniques. **Circle 465 on Reader Service Card.**

Readouts digital and message

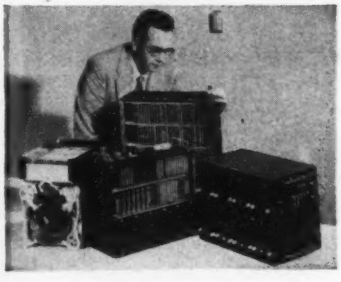
MILMAN ENGINEERING CO., 1831 Pontius Ave., Los Angeles 25, Calif. A line of newly developed digital and message readouts offers many possibilities for more effective presentation of data and informa-

tion in bench, panel, and console applications.

The digital readouts present lighted digits zero through nine and decimal point, or other information such as polarity signs or special symbols. Modular design allows side by side mounting of the units for in-line presentation of information.

Message readouts will display, separately in one panel area, up to three different color-coded printed messages, greatly increasing the accuracy of visual observations. Message and color combinations are made to suit individual requirements. Superpositioning of messages in the readout reduces the amount of panel area required to present a given amount of information and eliminates panel art work and engraving.

The units are designed for operation on 6, 14, or 28 v. **Circle 466 on Reader Service Card.**



Digital Computer for military aircraft

THE RAMO-WOOLDRIDGE CORP., 5500 W. El Segundo Blvd., Los Angeles, 45, Calif. The RW-30 digital airborne computer is designed to provide a lightweight, compact computing-control center for high-performance military aircraft. A completely transistorized device, it employs specially designed digital computing techniques and will perform all computations for navigation, fire control, bombing and weapon control with the speed demanded by modern weapons systems.

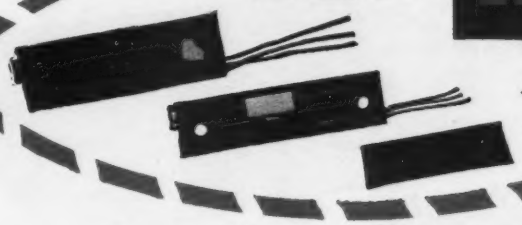
The complete computer has a volume of 4.19 cu ft and weighs only 203 lb. It consists of four separately packaged units—magnetic drum storage unit, arithmetic

NEW SUBMINIATURE

HIGH TEMPERATURE

TRIMMER

by ITC



ACTUAL SIZE

Now available as a wirewound or film type trimmer that is moisture proof, subminiature in size and withstands a temperature of 225°C., in a higher resistance range.

FEATURES:

Type RTW (wirewound) Resistance Range 100 ohms to 100,000 ohms

Type RTF (film) Resistance Range 100 ohms to 25,000 ohms, providing infinite resolution

25 turn lead-screw adjustment

Unique stop-overide safety mechanism

Housing of High Temperature Molded Plastic

Variety of mountings: Printed Circuit Lugs
Printed Circuit Wires
Tinned Leads

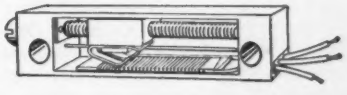
Virtually hermetic sealed meets Mil std. 202 Procedure 106 Humidity Test with rated power applied

Precious metal take off and end tabs

Dual stainless steel contacts on winding and slip ring for extra reliability

Power rating of .83 watts at 80° C., .1 watt at 200° C.

Engineered, quality controlled manufacture and environmental tested to meet the exacting demands of missile and other military applications, make these new low cost trimmers a long-sought contribution to design and production problems.



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ELIN POWER OSCILLATORS...

to "System-mate" Your Equipment Requirements!

CABINET MODEL
DK-102 (2 watts)
DK-106 (6 watts)

RACK MODEL
DK-102R (2 watts)
DK-106R (6 watts)

Pat. Pending.

In applications concerning strain gauges, bridge-type transducers, time correlation, precision 400 cycle gyro testing, process control and preflight missile checkout, ELIN Precision Power Oscillators prove compatible and, in combination with other equipments, readily yield superior systems!

The desirable features of ultra-precise frequency and amplitude stability, low distortion and high output power capacities, make ELIN Precision Power Oscillators the ideal "System-mate" in these applications, and are derived from an exclusive High-Q LC tuned circuit and a special voltage-sensitive bridge combined in a circuit employing a large amount of negative feedback.

FREQUENCY (FIXED)—250 cps. to 15,000 cps. **VOLTAGE (OUTPUT)**—10, 30 & 100 volts RMS, all with floating center-tapped output. **DISTORTION**—0.1% maximum harmonic content, 0.05% maximum AC hum, 0.01% maximum noise. **CALIBRATION ACCURACY**—±0.02% under usual lab ambient conditions*, checked against station WWV as a primary standard. **FREQUENCY STABILITY**—±0.5% maximum, under usual lab ambient conditions*, ±0.02% maximum per ±10 volts variation in line voltage, ±0.05% maximum, zero to full load. **AMPLITUDE STABILITY**—±0.1% maximum under usual lab ambient conditions*, ±0.02% maximum, per ±10 volts variation in line voltage, ±0.2% maximum, zero to full load.

Special models operating from other prime power sources, with higher power capacities and at other frequencies supplied to your specs in cabinet or rack styles. Write today!

*Lab ambient, 10°C to 40°C.

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elin® / Precision Power Oscillators

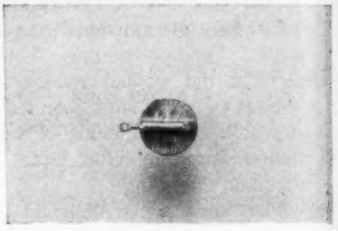
ELECTRONICS INTERNATIONAL CO.

145 West Magnolia Boulevard, Burbank, California

Special Products Division of International Electronic Research Corporation, Burbank, California

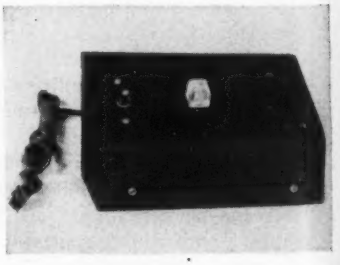
and control unit, input-output unit, and clock generator and power supply unit. Subminiature packaging techniques and silicon semiconductor circuitry are used throughout.

The RW-30 can conduct 4,000 complete arithmetic operations per sec, including access time and requires only 400 w of power, permitting a significant saving in aircraft auxiliary power equipment. **Circle 467 on Reader Service Card.**



Tiny Thermostat for −65 C to +150 C

CHATHAM CONTROLS CORP., 33 River Road, Chatham, N. J. The new model WP thermostat features a ⅜ in. diameter and 0.690 in. body length. It incorporates the same type of bimetal actuated contact, extreme simplicity, reliable performance, accurate temperature control, fast thermal sensing and long contact life as the manufacturer's other models. The device is rated at ½ ampere for 6-28 v a-c or d-c and 115 v a-c circuits. It has an externally adjustable temperature range from −65 C to +150 C. **Circle 468 on Reader Service Card.**



Surge Limiter has varied uses

ATLANTIC ELECTRONICS LABORATORIES, P. O. Box 918, Asbury Park, N. J. The Surge-Volt Master

is designed to limit to reasonable values the surge current when equipment such as radios, tv receivers, amplifiers, low-power transmitters, expensive test equipment and the like are turned on. After a suitable pre-heating period, full line voltage is applied to the load in question. Then a built-in voltage regulator maintains the line voltage approximately at 110 v, thus prolonging the life of such components as tubes, resistors, capacitors and the like. Presently available are Surge-Volt Masters in the 50-, 100-, 150-, 200-, 250-, 300- and 375-w ranges.

The Surge-Volt Master should prove useful in technical schools and universities, industrial production lines and laboratories. Circle 469 on Reader Service Card.

UHF Blade Antenna for 225-400 mc band

Dorne & Margolin, Inc., 30 Sylvester St., Westbury, L. I., N. Y. Type DM-C7 antenna is designed to operate in the 225-400 mc band for use with communication and data link equipment. This antenna is a highstrength swept-back aluminum blade, with a height of 7¾ in. from the aircraft skin, designed for use at speeds well into the supersonic region. Maximum thickness of the antenna is substantially less than 10 percent of the average chord length.

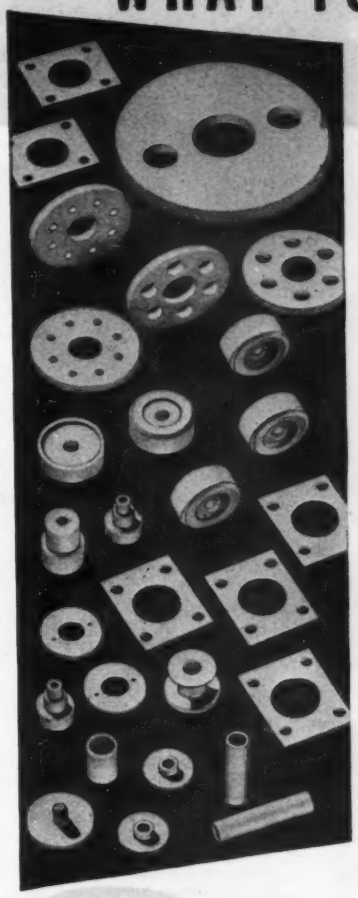
The antenna is designed to meet the environmental requirements of MIL-T-5422C and paragraph 412 of MIL-E-5272A. It can withstand more than 8 lb per sq in. lateral

TEFLON*

PARTS OR MATERIALS FOR UHF APPLICATION?

FOR MINIATURE AND SUB-MINIATURE COMPONENTS?

YOU CAN GET JUST WHAT YOU WANT



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FOR: insulators of all types, sleeves or inserts, capacitor seals, feed through insulators, bushings, slot liners, coaxial spacers, layer insulation or any other parts or forms subject to high charge, extended frequency range, mechanical and thermal shock, extreme temperatures and climatic conditions.

You can order in any quantity and be sure of true Teflon performance, because "John Crane" gives you these *plus* factors: complete uniformity throughout, high density control, freedom from flaws and rigid adherence to your specifications.

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Dielectric Strength: 480 v/mil.
Dielectric Constant (60 to 10^8 cycles): 2.0
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Volume Resistivity: 10^{15} ohm-cm
Surface Resistivity: 3.6×10^6 megohms
Surface Arc-Resistance: does not track
Temperature Range: −450° to +500°F.
Chemical Resistance: completely inert
Moisture Absorption: zero

Crane Packing Co., 6402 Oakton St., Morton Grove, Ill. (Chicago Suburb).

In Canada: Crane Packing Co., Ltd., Hamilton, Ontario.

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

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FLIGHTCOM

MODEL 400-12/24 SERIES

VHF-FM for AIRCRAFT

Provides communications between ground FM systems and executive, patroling and utility aircraft. Used by fishing fleets, petroleum producers, pipe line helicopters, State police, Conservation departments, crop dusters, power companies and departments, of the U. S. government.

Model 400-12/24 Chassis

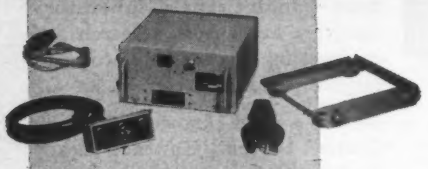
All FLIGHTCOM models are on "List of equipment acceptable for licensing" and are certified with the Federal Civil Defense Administration.

FEATURES:

- **COMPACT** . . . Case size 14" x11½"x6½"
- **LIGHT** . . . 22 lbs. (without antenna and speaker)
- **POWERFUL** . . . 25 watts output
- **UNIVERSAL** . . . instantly changed from 12 volt to 24 volt operation
- **EFFICIENT** . . . low battery drain: on 12 volt—total standby. 4.5 amps, transmitting 10 amps. on 24 volt—total standby 2.5 amps, transmitting 5 amps.
- **LOUD** . . . 1 watt minimum with less than 8% distortion.
- **PERFORMANCE** . . . identical with ground systems.
- **QUALITY** . . . exceptional value/price ratio.

ATTENTION DEALERS!
Write for available territories.

FLIGHTCOM PACKAGE

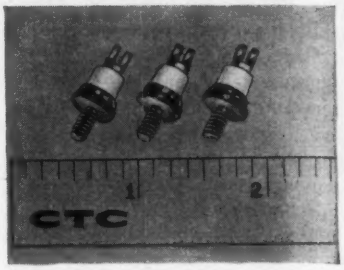


Model 400-12/24

DESIGNERS AND MANUFACTURERS OF RADIO COMMUNICATIONS EQUIPMENT

COMMUNICATIONS COMPANY, Inc.

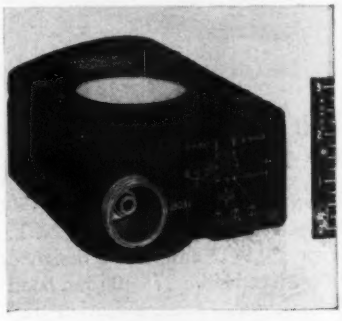
static load. Weight is approximately 20 oz and vswr is less than 2.5:1.0 over the 225-400 mc band. **Circle 470 on Reader Service Card.**



Insulated Terminals split type

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. Split solder terminals can be ordered in a wide variety of sizes and mounting studs, either in silicone impregnated ceramic, grade 15 (per JAN-1-10) or with Teflon insulation. Terminals are silver plated brass.

Three specific mounting studs are available: threaded (a variety of threads and lengths), rivet (several different lengths), and internally threaded. **Circle 471 on Reader Service Card.**

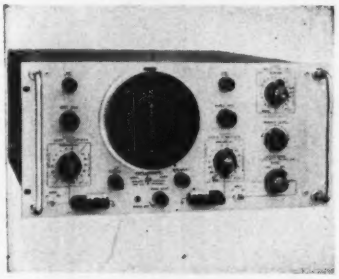


Pulse Transformer for airborne radar

SPECIALTIES, INC., Skunks Misery Road, Syosset, L. I., N. Y. A new series of high power pulse transformer assemblies, designed to match the impedance of a pulse forming network to a magnetron oscillator in a line type modulator are now being produced. They feature compactness and a high degree of resistance to temperature

variations, mechanical shock and vibration.

A self-contained filament transformer, a radio noise filter and bypass capacitors are provided so that the magnetron can be properly driven from a pulse forming network and a 115 v, 400 cps power source. Models are available for use with a 50-ohm pulse forming network and a 2J51A, 4J52 or 6543 magnetron. **Circle 472 on Reader Service Card.**



Oscilloscopes two general purpose types

HEWLETT-PACKARD Co., 275 Page Mill Road, Palo Alto, Calif. The 130BR d-c to 300 kc high sensitivity oscilloscope, and the 150 AR d-c to 10 mc h-f oscilloscope, designed especially for mounting in a standard 19 in. equipment rack, have been announced. Model 130 BR (illustrated) has electrically similar vertical and horizontal amplifiers which have less than 1 deg relative phase shift at 50 kc an a 1 mv/cm sensitivity. Balanced signals may be used on the most sensitive ranges, hence many transducers may be connected directly to its terminals. Mounting is by front panel or by accessory brackets which permit easy withdrawal of the oscilloscope from the rack.

Model 150 AR d-c to 10 mc oscilloscope is mounted on slides for accessibility and features calibrated sweep magnifications of X5, X10, X50, and X100. Any portion of the magnified trace may be viewed. The 150 AR is used with plug-in vertical amplifiers; the 151A which has 5 mv/cm sensitivity, and the 152A dual trace amplifier, which has a 50 mv/cm sensitivity and presents two electrical

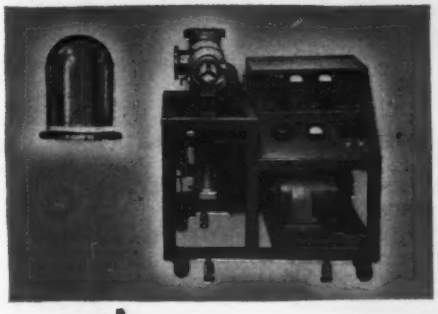
Kinney® PRESENTS...

NEW
MECHANICAL PUMPS

Featuring ultimate pressures to 10 microns or lower, the new KDH-65 and KDH-80 KINNEY Mechanical High Vacuum Pumps provide free air displacements of 65 cfm and 80 cfm respectively. These new pumps cover an important range in the KINNEY Line, which embraces single-stage and two-stage mechanical pumps, two and four-stage mechanical booster pumps with displacements to 5000 cfm.

NEW
THERMOCOUPLE GAUGE

A completely new approach which eliminates the need for recalibration or matching tubes when replacement is required, yet provides instantaneous response (½ S. or less) and exceptional accuracy (+ or — 10%). The KINNEY Compensated Thermocouple Gauge gives you complete interchangeability of gauge tubes among a number of tubes in one circuit, as well as from circuit to circuit. Here's new simplicity of control and many other advantages.

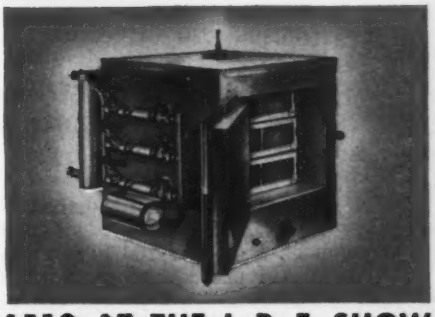


NEW
PUMPING SYSTEM

The PW-400 Packaged Pumping System features new performance and versatility. The vacuum pumping system consists of a KINNEY cold trap, high-speed fractionating diffusion and two-stage gas ballasted mechanical vacuum pump. A unique manifold-valve arrangement, whereby the intake fitting can be rotated through 90° from horizontal to vertical, permits easy conversion to a high vacuum evaporator.

NEW
VACUUM OVEN

The new KINNEY VO-3 Oven is an important development for drying and aging of transistors, diodes and other semiconductors. It features three separate chambers so manifolded that each chamber may be independently evacuated. Pyrex glass windows enable operator to observe work at all times. Forced draft heating provides temperatures to 400° F and the equipment may be used with inert gas atmosphere or high vacuum.



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Get this New Bulletin on the use of Vacuum in Crystal Growing and Production of Semi-Conductors.

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
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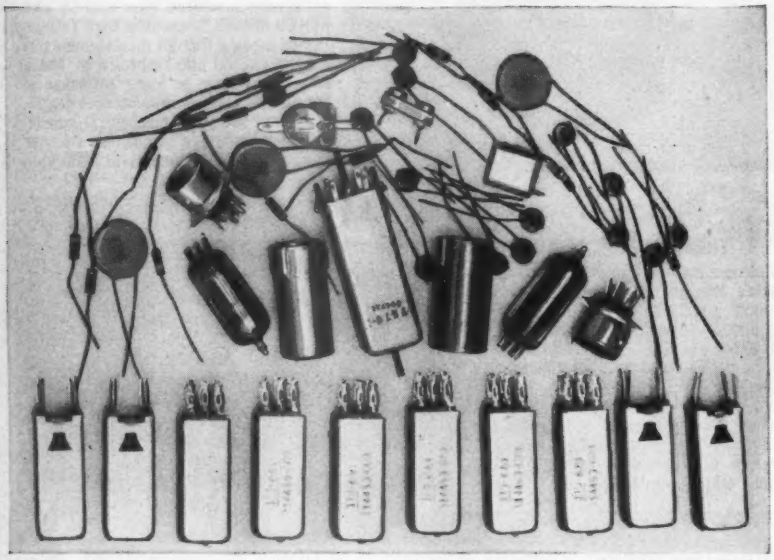

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AND REDUCE WEIGHT, SAVE SPACE,
IMPROVE PERFORMANCE AND RELIABILITY

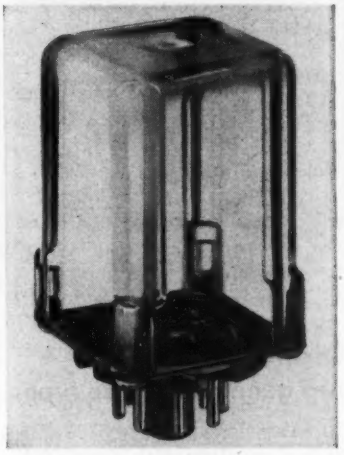
It will pay you to investigate how this unique component can improve performance and reduce costs of your communications equipment. Hycon Crystal Filters make possible single conversions in AM and FM receivers while retaining the important advantages of double and triple conversions. These units permit excellent reception in the presence of strong jamming or interfering signals. Center frequencies are accurate to .001%. Insertion loss is 1/10 of other filtering methods. Aircraft and guided missile environmental requirements are exceeded. Write for Crystal Filter Bulletin.

HYCON EASTERN, INC.

75 Cambridge Parkway Dept. A, Cambridge 42, Mass.

phenomena for simultaneous viewing. Both amplifiers pass d-c to 10 mc, and sensitivity is accurate within ± 5 percent.

Both oscilloscopes have a universal synchronizing circuit; a single preset switch position establishes optimum triggering for nearly all conditions. Model 130 BR is $650; 150 AR, $1,200; 151A, $200; and 152A, $250. **Circle 473 on Reader Service Card.**



Plug-In Enclosures transparent plastic

LINE ELECTRIC CO., 271 South 6th St., Newark 3, N. J., offers its new PE series of transparent plug-in enclosures in clear and colored plastic. They protect electronic assemblies from the dangers of dust, dirt, sand and human tampering. They feature standard RETMA 8 and 11 pin bases, high impact characteristics, excellent electrical properties; and are rated for 85 C ambient. Base pins can carry 10 amperes continuously. Enclosures are available in clear, green, blue, red, purple or amber plastic. Size is 1⅜ by 1⅜ by 2⅛ high. Weight is approximately 1¼ oz. **Circle 474 on Reader Service Card.**

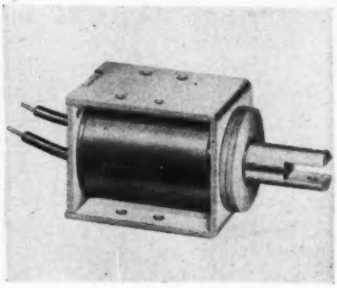
Single Coil Relay latching type

POTTER & BRUMFIELD, INC., Princeton, Ind., has announced a new single coil latching relay that selects alternate circuits or alternate

circuit modes on successive impulses. Designated the PC, the relay employs an armature driven rocker type actuator to transfer one, two, three or four dpdt snap switches.

Gold flashed silver cadmium oxide contacts are rated at 10 amperes, 115 v a-c resistive. The relay can be operated from a-c or d-c sources and provides positive transfer on a single 30-millisec impulse. The spring action of the contact arms effectively latches the relay in the transferred position when coil power is removed.

The PC was designed primarily for on-off and reversing features. It is used for remote tv controls, garage door openers, flow control motors and other applications requiring a low cost means for a transferring between alternate circuits at undefined periods. **Circle 475 on Reader Service Card.**



Powerful Solenoid for a-c or d-c operation

GUARDIAN ELECTRIC MFG. CO., 1621 West Walnut St., Chicago 12, Ill. A new more powerful version of the standard No. 4 solenoid is now being offered for a-c or d-c operation in both intermittent and continuous duty types. The new unit, equipped with $\frac{1}{4}$ in. diameter tapered plug and plunger, is said to lift up to 9 lb. Plunger stroke is adjustable from $\frac{1}{32}$ in. up to $\frac{3}{4}$ in. Two $\frac{1}{32}$ in. steel washers are welded to the front of the field piece to increase power efficiency of the solenoid. The plunger has slotted end with $\frac{1}{8}$ in. diameter holes for coupling.

This particular solenoid measures $1\frac{7}{16}$ in. wide by $1\frac{3}{8}$ in. high by $2\frac{3}{16}$ in. long, exclusive of plunger. The

LINDE *Rare Gases*

Ne
A Kr
He Xe

Symbol of Highest Purity

...in cloud and bubble chambers

...in radiation detecting equipment

...in gas discharge devices and glow tubes

...as protective atmospheres for crystal growing

Rare gases produced by LINDE are continuously analyzed by mass spectrometer, gas chromatography, and chemical and physical methods. These analytical checks assure you of the purest rare gases obtainable.

LINDE argon, neon, helium, xenon and krypton are available in one- and two-liter glass bulbs, or in steel cylinders under pressure. Mixtures of gases are also available to your specifications. Prompt delivery is assured.

For detailed data on the physical and electrical properties of LINDE Rare Gases, write Dept. BD-32, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

Linde TRADE-MARK Ne Kr A He Xe RARE GASES

UNION CARBIDE

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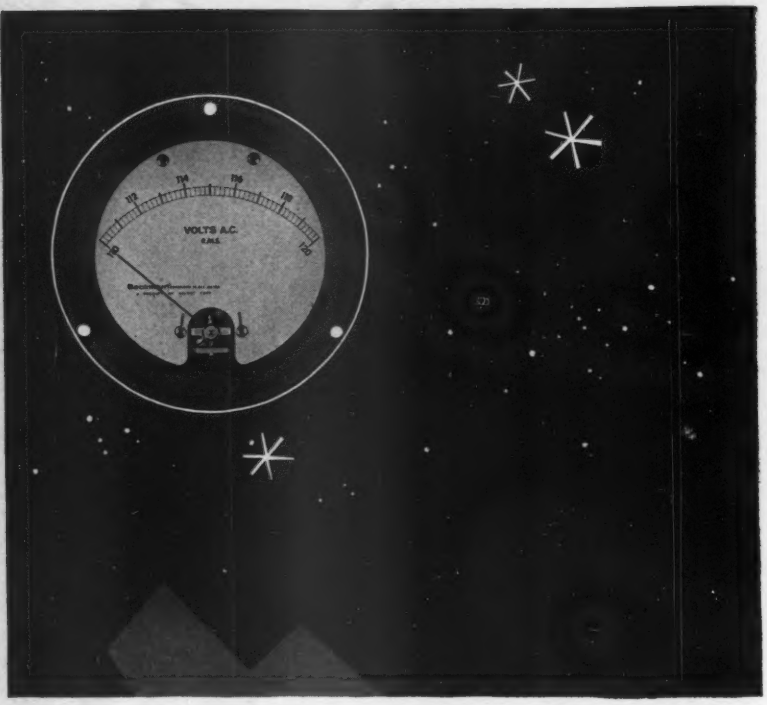

Even over the hill and far far away,
Beckman Expanded Scale Voltmeters read

RIGHT .*. AT A GLANCE

BECKMAN EXPANDED SCALE VOLTMETERS read sharp and clear: day or night, dark or light, near or far, up or down, fast or slow.

HOW'S IT POSSIBLE? We've simply expanded the useful portion of a conventional scale, completely eliminated the mass of non-essential, impossible-to-read divisions.

WHICH MEANS? Accuracy to 0.3% of center-scale value. And resolution of the highest order: 0.1 volt.

APPLICATIONS? Whether aground or aloft, there's a Beckman Expanded Scale AC or DC Voltmeter to meet your voltage measuring requirements. Eight basic models in 126 shapes, sizes and ranges for panel installations in ground systems, aircraft and test equipment.

MORE INFORMATION? Yours for the asking . . . write for data file 34A.

Beckman® / Helipot Corporation

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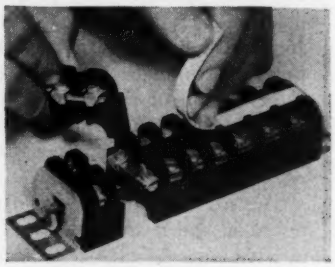
new solenoids are available from the manufacturer for any specific voltage from 6 to 230 v, 60 cycles a-c or d-c. All d-c units are also available for 400-cycle operation. **Circle 476 on Reader Service Card.**



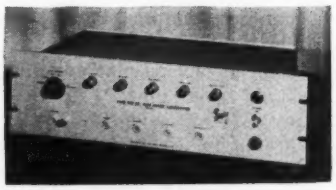
Terminal Block compact device

GEMCO ELECTRIC CO., 25685 W. Eight Mile Road, Detroit 40, Mich. A new compact terminal block is available for custom assembly or in factory assembled strips rated at 600 v a-c or d-c, 15, 25, and 50 ampere ratings.

Features are: snap-in marking strip, and snap-on terminal block, both of which make modifications to a mounted terminal strip a fast operation.

No special mounting rods are required—standard ⅛ in. round cold rolled steel fits each molded piece and permits rapid assembly of special requirements. All three current ratings can be assembled into one mounting strip.

Open-type terminals and pan head screws which have captive wire clamps make wiring easy. **Circle 477 on Reader Service Card.**

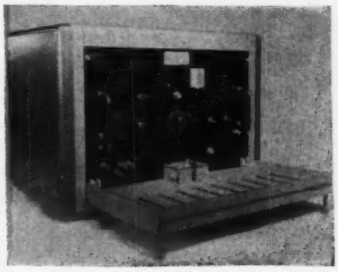


Time-Mark Generator rack-mounting unit

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type RM181 generates five time markers—1,

10, 100, 1,000, and 10,000 μsec, and a 10-mc sine wave. Output amplitude is about 2 v. All six outputs are available at a common coaxial connector through use of a selector switch, and the five time markers are also available at front-panel binding posts. The markers and sine wave are derived from a 1-mc crystal-controlled oscillator with a frequency tolerance of about 0.03 percent and a short time stability, after initial warmup, of about 0.005 percent per hour. Dimensions are 5¼ in. high, 19 in. wide 9¼ in. rack depth (approximately 3 in. additional required for power cord), 11 in. overall depth. Price is $250.

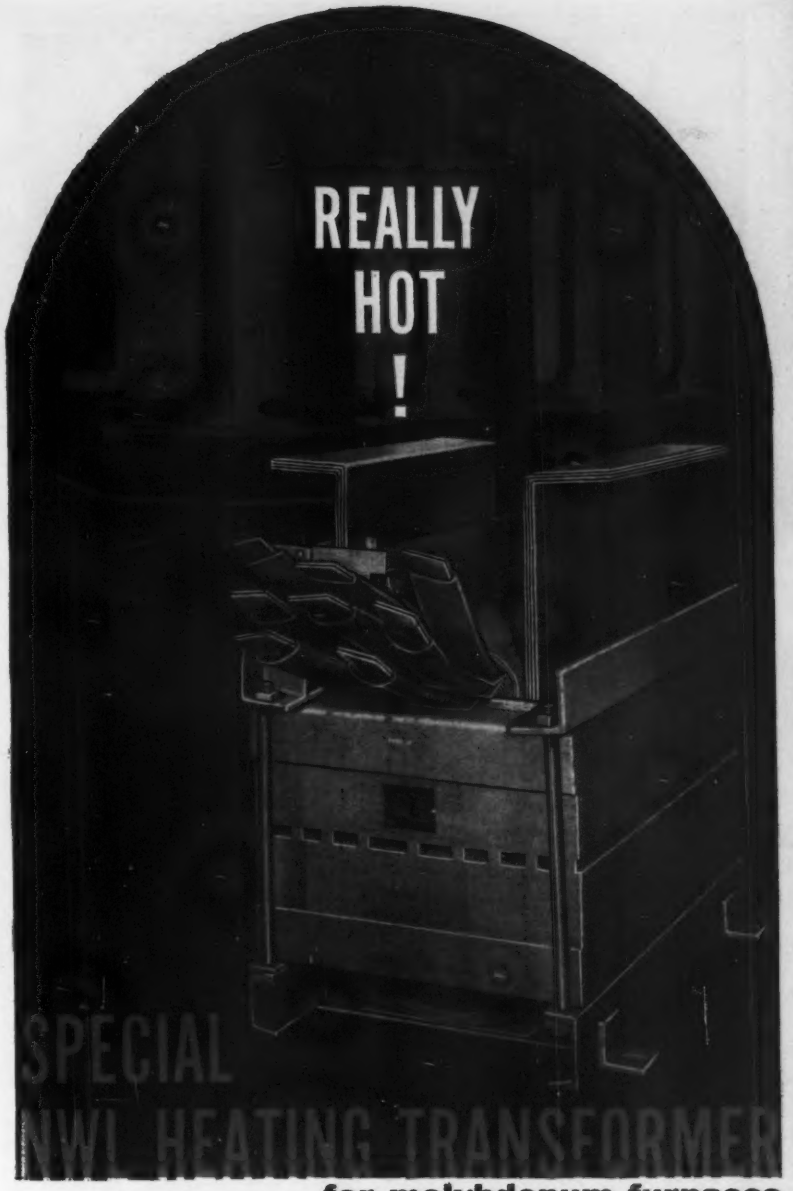
The RM181 is also available with a temperature-stabilized crystal oven installed. This is priced at $270. Frequency stability is 2 ppm over a 24-hour period. **Circle 478 on Reader Service Card.**



Core Tester displays on cro

Mack Electronics, 40 Leon St., Boston 15, Mass., has available a tester which provides a display of magnetic toroid characteristics. Model 123 core tester provides a display of coercive force, saturation flux density, B_r : B_m ratio, differential permeability and shows the shape of the hysteresis loop. The display, made on a cro, permits a quick evaluation of the basic core characteristics in relation to a specific circuit application.

The core tester is based upon current reset. The reset current is variable up to 6 amperes. The test probe is a single wire solid rod which permits manual testing rates up to 400 cores per hour. **Circle 479 on Reader Service Card.**



for molybdenum furnaces

This transformer has a 10,000 Ampere secondary with a maximum of 5 volts. The primary taps are extended to reduce secondary to 0.75 volts. The secondary copper is ⅜" thick and 16" long, over which is connected and built-in a 5 Ampere current transformer. This special transformer is made for air-blast cooling as the physical size had to be kept extremely small.

The heating transformer, a new member of the well-known family of NWL custom-built Transformers, is made to fit the particular needs of the user. Each Nothelfer transformer is individually tested for core loss polarity, voltage, corona, insulation breakdown and aging characteristics and must meet all customer's requirements before shipment. We shall be glad to receive your specifications and quote you accordingly.

NWL ESTABLISHED 1920 NEMA

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NOTHELFER WINDING LABORATORIES, INC., P. O. Box 455, Dept. E3, Trenton, N. J.
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Features an insulated rocker arm activated by a single coil, instead of the usual two. Ideal for machine controls, appliances, positioning devices, remote TV controls and other applications where opposite switching is desired each time circuit is pulsed. Contact combinations up to 4 "C"; rated 7½ amperes @ 115 V. AC resistive.

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Suitable for use in a wide range of applications. For AC or DC operation. Compact size, lightweight. Shock and vibration resistant. Positive contact pressure. Contact combinations up to 3 "C". Contact rating, 5 amp. resistive with 5/32" dia. (10 amp. with 3/16" dia.). Available open, or in plastic dust covers with plug-in feature, as illustrated.

Send For Details

Literature

MATERIALS

Insulating Material. Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J. Technical data sheets, typical curing conditions and samples of Stanpreg A-Ph heat resistant phenolic resin pre-impregnated glass cloth are now available. **Circle 500 on Reader Service Card.**

Magnetic Shielding. Magnetic Shield Division, Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill. Data sheet 134 illustrates and describes the new seamless, non-shock sensitive, non-retentive Netic magnetic shields. The shields discussed are designed for greater effectiveness in attenuating both high and low frequencies of substantially increased transformer radiation in transistorized power supplies. **Circle 501 on Reader Service Card.**

Nickel Clad Copper Wire. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A technical information bulletin describes the chemical composition, mechanical properties, conductivity and resistivity of Kulgrid 28 nickel clad copper wire developed for high temperature applications. **Circle 502 on Reader Service Card.**

COMPONENTS

Digital Devices. Anatran Corp., 45 West Union St., Pasadena, Calif. "Digitometry, A Concept of Digital Control and Indication" is the title of a new four-page technical bulletin. It describes five new components for use as digital actuators and feedback devices in servo and instrumentation system. **Circle 503 on Reader Service Card.**

Electromechanical Products. G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio. Bulletin No. 1157LS describes the company's line of Ledex rotary solenoids, selector switches, hermetically sealed selectors, and Synchramental

of the Week

stepping motors. **Circle 504 on Reader Service Card.**

High Speed Commutator. Wiancko Engineering Co., 255 N. Halstead St., Pasadena, Calif. Engineering data sheet 857-409 covers the series 25-1100 high speed commutator. The instrument discussed is a small, solid-state, electronic commutator designed to sample inputs from 10 to 100 pickups, at rates up to 30,000 samples per sec. **Circle 505 on Reader Service Card.**

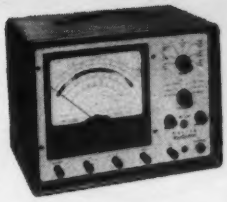
Metal Film Resistor. Weston Electrical Instrument Corp., A Subsidiary of Daystrom, Inc., Newark 12, N. J. A 4-page folder describes the Vamistor, a metal film precision resistor in which the resistance element, actually a ribbon of metal, is thermally fused to the inside wall of a Steatite tube having silver terminals fired to each end. **Circle 506 on Reader Service Card.**

Metallized - Paper Capacitors. Aerovox Corp., New Bedford, Mass., has released a new engineering bulletin on type P83Z microminiature Aerolite molded thermoplastic metallized-paper capacitors. It provides complete specifications, size and capacitance tables as well as insulation resistance tables on these small capacitors. **Circle 507 on Reader Service Card.**

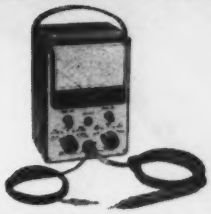
Precision Potentiometer. Beckman/Helipot Corp., Newport Beach, Calif. Current details of the series 7600 precision pot are completely covered in data sheet 1273 (superseding 54-14). In addition to dimensional drawings and descriptive text about the 10-turn, 1 13/16 in. diameter pot, the four-page data sheet now includes a table of coil characteristics for resistance values ranging from 350 to 450,000 ohms. **Circle 508 on Reader Service Card.**

Printed Circuit Connector. Dejur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. An illustrated bulletin gives specifications, outline dimensions and

in the lab, or on the line...

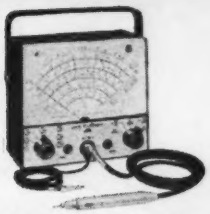


Master VoltOhmyst® WV-97B—incorporates all the essential features of the Senior VoltOhmyst plus 7½" meter, current ranges enabling current measurements from 10 ma to 15 amperes, zero-center scale adjustment for discriminator alignment. $137.50*



Junior VoltOhmyst® WV-77C—big value in vacuum-tube-volt-ohmmeters! Factory calibrated and tested to laboratory standards. Measures dc from 100 millivolts to 1200 volts; ac from 100 millivolts to 1200 volts rms; resistance from 0.2 ohm to 1,000 megohms. $59.50*

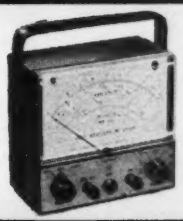
for Accuracy, Dependability...



Senior VoltOhmyst® WV-98A—ideal for TV, radar and other types of pulse work. Provides accuracy of ±3% on both ac and dc measurements. Measures directly peak-to-peak values of complex wave forms and rms values of sine waves. Features ±1% multiplier and shunt resistors, a 2% meter movement, ±3% on AC and DC voltages. Less than ±1% tracking error. Large (6½" w.) full-vision meter provides easy readings. $79.50*

Ultra-Sensitive DC Microammeter WV-84B—popular choice for industrial, chemical and general laboratory applications. Designed to measure currents from 0.0002 to 1000 microamp. Can be used as ohmmeter to measure resistance in the order of billions of ohms. Self-contained batteries permit use for field applications. Low current drain tubes extend battery life; meter protected from accidental overloads. $110.00* (less batteries)

and Economy...



High-Sensitivity AC VTVM WV-74A—ALL NEW AC VTVM equipped with large 7-inch meter. Nine voltage ranges, from 0.01 to 100 volts. Features wide frequency response (within ½ db from 20 cps to 500 KC). Input resistance and capacitance with "lo cap" probe—10 megohms and 13 μμf; with direct probe—1 megohm and 95 μμf. Overall accuracy ±5% of full scale. Built-in amplifier with gain of approximately 38 db and output impedance of 400 ohms can be used as a preamplifier for numerous applications. $99.50*

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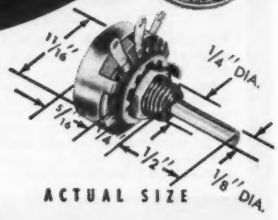

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Sub-Miniature Variable Resistors

Smaller than a dime, these units will meet MIL-R-94B resistance change requirements under twice their rated load.

These Model JP and JL controls have extremely high wattage dissipation due to Centralab's ICE (Interfused Composition Element). Their extreme electrical stability makes them ideal for applications involving high temperature and other severe operating conditions.

- Meet or exceed MIL-R-94B requirements for moisture resistance, insulation resistance, thermal cycling, etc.
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Ask your distributor for Catalog 30 listing these stock models. For complete technical information write to Centralab for Engineering Bulletin EP-63.

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general information on the new series 600-93 printed circuit connector which features bellows action contacts. **Circle 509 on Reader Service Card.**

R-F Filters. All-Tronics, Inc., 45 Bond St., Westbury, L. I., N. Y., has published a four-page catalog listing custom r-f filters as stock items ready for off-the-shelf delivery. **Circle 510 on Reader Service Card.**

EQUIPMENT

Instruments. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Volume 32, Numbers 8 and 9, of the Experimenter deal with a 180-600 mc oscillator and capacitance bridges, respectively. **Circle 511 on Reader Service Card.**

Measuring Apparatus. Ad-Yu Electronics Lab, Inc., 249 Terhune Ave., Passaic, N. J. A single-page bulletin illustrates and describes the new type 202 highly accurate Vectorlyzer which makes possible a number of measurements—such as small phase angles, vector sum or vector difference of two voltages, ratio of two voltages, and others. **Circle 512 on Reader Service Card.**

Microwave Test Equipment. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md. A 32 page 2-color catalog describes microwave test equipment in the following fields: coaxial attenuators, d-c to 10,000 mc; insertion loss test sets, 0 to 30 db; modulated r-f sources, 50 to 2,000 mc; modulator, bolometer preamplifier; termination, d-c to 10,000 mc. **Circle 513 on Reader Service Card.**

Production Machinery. Kahle Engineering Co., 1307 Seventh St., North Bergen, N. J. Ten new catalog sheets cover machinery for the production of semiconductors and tubes. They include: an automatic whisker former and welder, a transistor button stem machine, an automatic final seal machine for glass bodied diodes, two manual type final seal machines for glass diodes, a crystal pulling machine,

a motor speed programmer used with crystal growers, a fusing furnace for alloy junction transistors, and a specially adapted lead wire welder. An appendix sheet contains some useful tables. **Circle 514 on Reader Service Card.**

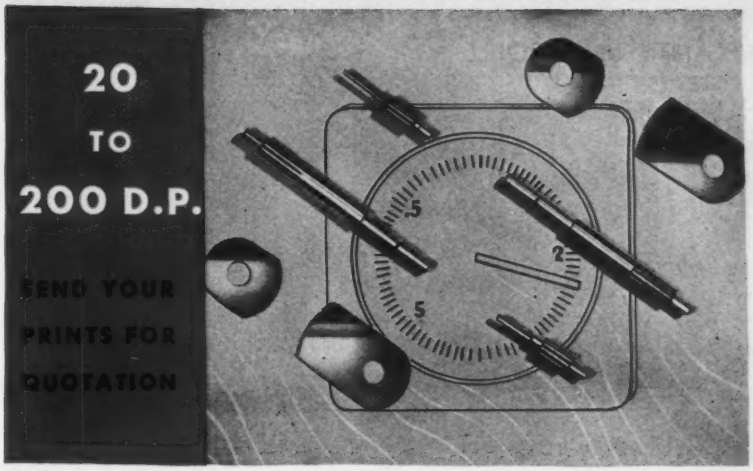
Remote Area Monitoring. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio. Form 3045A is a four-page bulletin descriptive of the company's remote area monitoring systems. It covers the basic units in the systems and gives specification data such as ranges, response, accuracy and stability. Model numbers, suggested uses, dimensions and weights are also included. **Circle 515 on Reader Service Card.**

Wide-Band Power Amplifier. Resdel Engineering Corp., 330 South Fair Oaks Ave., Pasadena 1, Calif., is issuing a technical folder on model 90173 X-band pulse/c-w wide-band power amplifier used in simulation of jamming signals, microwave filter testing, antenna testing and propagation studies; and attenuator testing. **Circle 516 on Reader Service Card.**

FACILITIES

Fabricating Facilities. D. E. Makepeace Co., Pine and Dunham Sts., Attleboro, Mass. A 5-page bulletin describes the melting, fabricating, testing and quality-control facilities available in the company's new nuclear and specialty metals plant. **Circle 517 on Reader Service Card.**

Pulse Techniques. Navigation Computer Corp., 1621 Snyder Ave., Philadelphia 45, Pa., has announced a newsletter, *Pulse Techniques*, about new applications for transistorized digital circuits. The first issue describes basic shift register operation and covers several applications of shift registers as pulse pattern and pulse burst generators. Future topics will include magnetic core testing, binary and decimal counter logic, arithmetic operations and magnetic tape and drum recording systems. **Circle 518 on Reader Service Card.**



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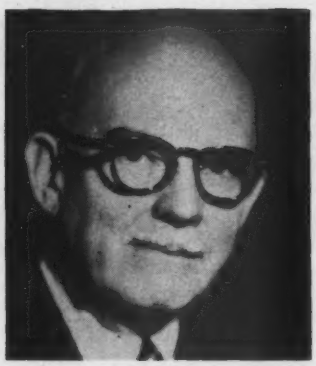

Top row (left to right), GEORGE W. BAILEY, Chairman General Committee; STUART L. BAILEY, Vice Chairman, General Committee; DONALD G. FINK, Ex-Officio member, General Committee.

Bottom row (left), GEORGE HALLER, Chairman, Technical Program Committee; (right), ROBERT C. SPRAGUE, Guest Speaker, Annual Banquet.

IRE Ready For '58 Annual Convention

A COMPREHENSIVE 55-session program, involving some 280 papers ranging over 27 fields of radio-electronics, has been set for the 1958 IRE National Convention on March 24-27 in New York City. Thirty-three sessions will be held at the Waldorf-Astoria Hotel and 22 at the New York Coliseum. (In listing the program, locations are referred to as WA and C, respectively). An attendance of 50,000 engineers and scientists from 40 countries is expected.

The Coliseum will also house the Radio Engineering Show, at which approximately 20,000 items of the most advanced electronic apparatus will be displayed by 850 exhibitors, much of it for the first time. The exhibitors represent 80 percent of the total production capacity of the electronics industry.

High point of the technical program will be two special sessions on Tuesday evening, March 25. Panels of the leading experts will discuss "Electronics in Space" and "Electronics Systems in Industry."

The technical program was organized by representatives of 27 IRE professional groups under the chairmanship of George L. Haller, general manager of the General Electric Co. Defense Electronics division. The program covers a wide range of currently important topics, including controlled thermonuclear power atomic clocks and Masers, automation system of postal operations, medical electronics.

Presented for the first time are sessions on education, engineering writing and speech, and r-f interference, due to the establishment of new IRE Professional Groups in these fields within the past year.

The full program follows:

SESSION 1
Monday, March 24
2:30-5:00 P.M. (WA)

TUTORIAL SESSION ON DETECTION THEORY AND ITS APPLICATIONS

Detection as a Statistical Decision Problem, by David Van Meter, Melpar Research Dept.

Some Communications Applications of Detection Theory, by W. B. Davenport, Jr., Lincoln Lab., MIT.

Some Applications of Detection Theory to Radar, by Wm. McC. Siebert, Electrical Engineering Dept., MIT.

Human Factors in Detection and Speech Communications, by J. P. Egan, Psychology Dept., Indiana University.

SESSION 2
Monday, March 24
2:30-5:00 P.M. (WA)

VEHICULAR COMMUNICATIONS

Direct Despatch Service, by A. J. Dinnin, Bell Tel Co. of Canada.

A Unique Radio System Designed for Flood Forecasting, by W. C. Wray, Motorola, Inc.

A New Approach to Broadband Vehicular Antennas, by Helmut Brueckmann, U. S. Army Signal Engineering Labs.

Mobilization of Transistors, by R. J. Hansen, General Electric Co.

Vehicular Noise Problems in Modern Land Mobile Systems, by S. F. Meyer, Allen B. DuMont Labs., Inc.

SESSION 3
Monday, March 24
2:30-5:00 P.M. (WA)

TELEMETRY AND REMOTE CONTROL

The RCA Flight Data System, by C. N. Batsel, Jr., R. E. Montijo, Jr. and E. J. Smuckler, Radio Corp. of America.

A Pulse Position Telemetry System, by L. Weisman and E. S. Teltscher, Ford Instrument Co.

Sample and Hold Circuits for Time Correlation of Analog Voltage Information, by W. T. Eddins, Radiation, Inc.

A Transistorized Six-Channel Airborne

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From its beginnings this nation has been guided by great ideas.

The men who hammered out the Constitution and the Bill of Rights were thinkers—men of vision—the best educated men of their day. And every major advance in our civilization since that time has come from minds *equipped by education* to create great ideas and put them into action.

So, at the very core of our progress is the college classroom. It is there that the imagination of young men and women gains the intellectual discipline that turns it to useful thinking. It is there that the great ideas of the future will be born.

That is why the present tasks of our colleges and universities are of vital concern to *every* American. These institutions are doing their utmost to raise their teaching standards, to meet the steadily rising pressure for enrollment, and provide the healthy educational climate in which great ideas may flourish.

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Channel Selection for Multi-Carrier Telemetry, by L. S. Taylor and G. F. Bigelow, Range Instrumentation Dev. Division, White Sands Proving Ground, N. Mex.

Telemetering Receiving Station Time Pulse Detector, by J. Star, Applied Physics Lab., The Johns Hopkins University.

SESSION 4
Monday, March 24
2:30-5:00 P.M. (WA)

TECHNIQUES AND CRITERIA CONSIDERATIONS IN ELECTRONIC ENGINEERING

Use of Kros-Term System for Quick Retrieval of the Technical Detail from Large Pools of Information, by A. P. Vigliotta, U. S. Navy Tng. Device Cen., and K. D. Swartzel, Engleman and Co.

Techniques for the Presentation of Three-Dimensional Information, by E. J. Kennedy and E. F. LaForge, Rome Air Development Center, Griffiss Air Force Base.

Transistorized Airborne Military Television Techniques, by J. J. Kelly, Norden-Ketay Corp.

Design Criteria for Missile Automatic Test Equipment, by W. O. Campbell, The Martin Co.

Active Space-Frequency Correlation Systems, by W. E. Kock and J. L. Stone, Bendix Aviation Corp.

SESSION 5
Monday, March 24
2:30-5:00 P.M. (WA)

PANEL: EDUCATIONAL NEEDS IN SYSTEMS ENGINEERING

Chairman: R. P. Johnson, Vice Pres., Research and Development, The Ramo Wooldridge Corp.

Participants:

H. Chestnut, General Electric Co.

H. H. Goode, Dept. of E. E., University of Michigan.

S. Herwald, Westinghouse Electric Corp.

R. J. Kochenburger, Dept. of E. E., University of Connecticut.

W. K. Linvill, Dept. of Defense.

J. Moore, North American Aviation, Incorporated.

SESSION 6
Monday, March 24
2:30-5:00 P.M. (C)

ENGINEERING WRITING AND SPEECH

Roadblocks in Technical Writing, by T. Griggs, Eclipse-Pioneer Div., Bendix Aviation Corp.

Writing for a Technical Journal, by E. T. Ebersol, Jr., *Electronic Design*.

Non-Technical Help for Engineer-Writers, by R. B. MacPherson, Daystrom, Inc.

We Are What We Say, by A. Henesian, Lockheed Missile Systems Division.

Automatic Creation of Literature Abstracts (Auto-Abstracts), by H. P. Luhn, IBM Corp.

SESSION 7
Monday, March 24
2:30-5:00 P.M. (C)

RADIO FREQUENCY INTERFERENCE

Bandwidth Conservation in Pulse Modulated Radars, by R. A. Rosien and R. Shavlach, The University of Pennsylvania.

Measurement of Spurious Radiation from Missileborne Electronic Equipments, by A. L. Albin and C. B. Pearlston, Filtron Co., Inc.

Small, Lightweight, RF Interference Suppressors Using Transistors, by Walter Pecota, Sperry Gyroscope Co.

Transmission Interference in Low Level Instrumentation Systems, by J. C. Crosby, Consolidated Electrodynamics Corp.

Spurious Frequency Measurement in Waveguide, by Michael Morelli, Rome Air Development Center, Griffiss Air Force Base.

SESSION 8
Monday, March 24
2:30-5:00 P.M. (C)

ADVANCES IN PRODUCTION ENGINEERING

Automatic Transistor Classifier, by F. J. Morcerf, and L. F. Roehm, General Electric Co.

Circuit Packaging and Integration of Transistor Assemblies, by H. H. Hagens, U. S. Army Signal Engineering Labs.

Automatic Soldering Machine for Printed Circuit Assembly Boards, by W. L. Oates, Radio Corp. of America.

Wire Processing for Low-Volume Electronic Production, by R. D. Peters, General Electric Co.

"Case" History, by T. C. Combs, Zero Manufacturing Co.

Tension in Coil and Tape Winding, by E. J. Saxl, Tensitron, Inc.

SESSION 9
Tuesday, March 25
10:00 A.M.-12:30 P.M. (WA)

AUTOMATIC CONTROL—GENERAL

A Servo Pressure Control System for the Iron Lung, by G. A. Biernson, Sylvania Electric Products Inc., and J. E. Ward, Servomechanisms Lab., MIT.

Gain-Phase Relations of Non-Linear Circuits, by Emanuel Levinson, Sperry Gyroscope Co.

On the Design of Adaptive Systems, by H. L. Groginsky, Electronics Research Labs., Columbia University.

The Organization of Digital Computers for Process Control, by Geoffrey Post and E. L. Braun, Litton Industries.

A Self-Adjusting System for Optimum Dynamic Performance, by G. W. Anderson, J. A. Aseltine, A. R. Mancini, C. W. Sarture, Aeronutronic Systems, Inc.

SESSION 10
Tuesday, March 25
10:00 A.M.-12:30 P.M. (WA)

CONTROLLED THERMO-NUCLEAR POWER

Controlled Thermonuclear Fusion and Its Meaning for the Radio Engineer, by E. W. Herold, C. Stellarator Associates.

Hydromagnetic Instabilities—A Pictorial Approach, by Ira Bernstein, Project Matterhorn, Princeton University.

Microwave Measurements in Controlled Fusion Research, by Mark Heald, Project Matterhorn, Princeton University.

Measurements of Neutron Production in a Dynamic Pinch, by Robert Pyle, University of California, Radiation Laboratory.

Production of Intense Magnetic Fields and Their Relation to Fusion Reactors, by Morton Levine, Cambridge Research Center.

Plasmas for Propulsion, by Winston Bostick, Physics Dept., Stevens Institute of Technology.

SESSION 11
Tuesday, March 25
10:00 A.M.-12:30 P.M. (WA)

BROADCAST TRANSMISSION SYSTEMS

Video Modulation Limiter, by L. S. Sadler, Television Station WMTV.

Color TV Recording on Magnetic Tape,

Execs Dig In For IT&T Lab

CLAD in Arctic gear worn by International Telephone and Telegraph Corp. engineers and technicians who man the DEW line in Canada and Alaska, two officials of that company are pictured breaking ground for a new building for IT&T's research division, Federal Telecommunication Laboratories, at Nutley, N. J. When the ceremonial shovel failed to break the frozen ground for Henri Busignies, right, president of FTL, John E. Gingrich, president of Federal Telephone and Radio Co., another IT&T division, dug in with a pick. In the background is FTL's 300 ft microwave radio research tower.

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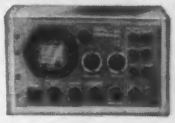

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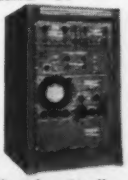

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Average power level	43 KW
Heater	6.3 volts, 30 A
Reservoir	3.0-6.0 volts, 3.0-8.0 A
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Peak forward anode voltage	33.0 kVdc max.
Peak anode current	2000 a max.
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by J. L. Grever, Radio Corp. of America.

An Automatic TV Level Control Using Vertical Interval Test Signals, by J. R. Popkin-Clurman and Frank Davidoff, Telechrome Mfg. Corp.

Report on Remote Control of a Directive Antenna System, by H. E. Rhea, Triangle Publications.

A Novel System for Feeding a Single Tower AM, FM and TV Signals, by A. C. Goodnow, Westinghouse Broadcasting Co.

SESSION 12
Tuesday, March 25
10:00 A.M.-12:30 P.M. (WA)

STEREOPHONIC DISC RECORDINGS

RIAA Engineering Committee Activities with Respect to Stereophonic Disc Records, by W. S. Bachman, Columbia Records, Inc.

The Westrex Stereodisk System, by C. C. Davis and J. G. Frayne, Westrex Corp.

Tracing Distortion in Stereophonic Disc Recording, by M. S. Corrington and T. Murakami, RCA Victor Television Div.

Compatibility Problems in Stereophonic Disc Reproduction, by B. B. Bauer and R. Snepvangers, CBS Labs.

Phonograph Pickups for Stereophonic Record Reproduction, by W. S. Bachman, Columbia Records, Inc., and B. B. Bauer, CBS Labs.

The Requirements of a Record Changer, Component Parts and Associated Equipment for Stereophonic Record Reproduction, by W. Faulkner, V-M Corp.

SESSION 13
Tuesday, March 25
10:00 A.M.-12:00 Noon (WA)

PLANNING AGAINST TIME

Weapons Systems Development, by Gen. Bernard A. Schriever, Air Force Ballistic Missile Div.

Commercial Product Development, by Robert Thalner, Sylvania Radio and Television Set Div.

Scientific Manpower, by Howard A. Meyerhoff, Scientific Manpower Commission.

SESSION 14
Tuesday, March 25
10:00 A.M.-12:30 P.M. (C)

AERONAUTICAL AND NAVIGATIONAL ELECTRONICS

A Vortac Traffic Control System, by P. E. Ricketts, Rome Air Development Center, Griffiss Air Force Base.

Airborne Vortac DME for Federal Airways System, by S. M. Dodington and B. B. Mahler, Federal Telecommunication Labs.

IDEA—Integrated Defense Early-Warning Air Traffic Control, by B. H. Baldridge, General Electric Co.

The AN/APN-96 Doppler Radar Set, by M. W. McKay, General Precision Lab., Inc.

Increasing the Traffic Capacity of Transponder Systems, by H. Davis and M. Setrin, Rome Air Development Center, Griffiss Air Force Base.

SESSION 15
Tuesday, March 25
10:00 A.M.-12:30 P.M. (C)

MEDICAL ELECTRONICS

A New Nipkow-Disk Scanner for Accurate Cytological Measurements, by H. S. Sawyer and R. C. Bostrom, Airborne Instruments Lab., Inc.

Electrocardiograph Telemetering (Radio), by J. C. Webb, L. E. Campbell and J. G. Hartsock, Agricultural Research Service, U. S. Dept. of Agriculture.

Electronics in Biochemical Spectroscopy, by M. Rogoff, Federal Telecommunication

Labs., and T. Gallagher, Sloan Kettering Institute.

Patient Data Systems for Hospitals, by G. Guy Knickerbocker and G. N. Webb, Dept. of Medicine, Johns Hopkins Hospital.

A New Intracardiac Pressure Measuring System for Infants and Adults, by A. Warnick, Scientific Lab., Ford Motor Co., and E. H. Drake, Dept. of Adult Cardiology, Henry Ford Hospital.

The Electronic Evaluation of Fetal Distress, by E. H. Hon, Dept. of Obstetrics and Gynecology, Yale University School of Medicine.

SESSION 16
Tuesday, March 25
10:00 A.M.-12:30 P.M. (C)

GENERAL COMMUNICATIONS SYSTEMS

Digital Communication Systems, by R. L. Plouffe, Federal Telecommunication Labs.

Constant Amplitude Speech, by P. J. Ferrell, Rome Air Development Center, Griffiss Air Force Base.

Exploitation of Physical Phenomena for Communications, by J. L. Ryerson, Rome Air Development Center, Griffiss Air Force Base.

Reduction of Intermodulation in Microwave Systems by Using Ferrite Load Isolators, by N. P. Weinhouse, Collins Radio Co.

The Effects of Pulse Shape and Frequency Separation on FSK Transmission Through Fading, by G. L. Turin, Hughes Research & Development Labs.

A 45 Channel PPM System, by S. M. Schreiner and B. McAdams, Federal Telecommunication Labs.

New Trends in Directional Communications, by R. C. Benoit, Jr. and Francis Coughlin, Jr., Rome Air Development Center, Griffiss Air Force Base.

SESSION 17
Tuesday, March 25
2:30-5:00 P.M. (WA)

CHANGING DEMANDS ON THE BREADTH OF ELECTRICAL ENGINEERING EDUCATION —A PANEL DISCUSSION

Chairman: J. D. Ryder, Dean of Engineering, Michigan State University.

Participants:

S. W. Herwald, Westinghouse Electric Corp.

H. Pollak, Bell Telephone Labs., Inc.

D. B. Sinclair, General Radio Co.

G. K. Teal, Texas Instruments, Inc.

SESSION 18
Tuesday, March 25
2:30-5:00 P.M. (WA)

ATOMIC CLOCKS AND MASERS

A Gas Cell "Atomic Clock" Using Optical Pumping and Optical Detection, by M. Arditi, Federal Telecommunication Labs., and T. R. Carver, Princeton University.

The Atomichron—An Atomic Freqency Standard—Physical Foundations, by A. O. McCoubrey, National Company, Inc.

The Atomichron—An Atomic Frequency Standard System Operation and Performance, by W. A. Mainberger, National Company, Inc.

Analysis of the Emissive Phase of a Pulsed Maser, by H. H. Theissing, F. A. Dieter, and P. J. Caplan, U. S. Army Signal Engineering Labs.

A Two-Cavity Unilateral Maser Amplifier, by Nisson Sher, Philco Corp.

SESSION 19
Tuesday, March 25
2:30-5:00 P.M. (WA)

BROADCAST TRANSMISSION SYSTEMS AND COMMUNICA-

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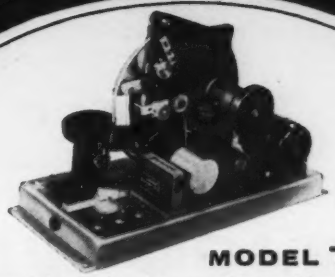

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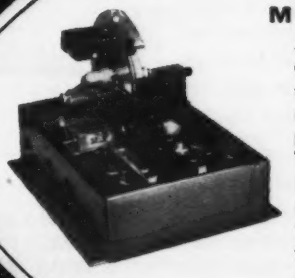

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TIONS SYSTEMS

Remote Control of 50 KW Transmitter, by R. N. Harmon, Westinghouse Broadcasting Co.

Report on Multiplex Experimental Work at WCAU-FM, by E. J. Meehan, Station WCAU-FM.

Field Test of Compatible Single Sideband at WABC, by R. M. Morris, American Broadcasting Co.

Improved CSSB Equipment for the Standard Broadcast Service, by L. R. Kahn, Kahn Research Labs.

An Incrementally Tuned, Drift Cancelled Communications Receiver, by Saul Fast and R. Caulk, National Co., Inc.

Polyphase Telephone Carrier System, by J. R. Mensch, Rome Air Development Center, Griffiss Air Force Base.

Tele-Map, by Henry Hoffman, Jr., Rome Air Development Center, Griffiss Air Force Base.

SESSION 20
Tuesday, March 25
2:30-5:00 P.M. (WA)

AUDIO, AMPLIFIER AND RECEIVER DEVELOPMENTS

Distortion in Audio Phase Inverter and Driver Systems, by W. B. Bernard, Bureau of Ships, Navy Dept.

Latest Advances in Extra Fine Groove Recording, by P. Goldmark, CBS Labs.

Design of a Transistorized Record-Playback Amplifier for Dictation Machine Application, by R. Fleming, The Gray Manufacturing Co.

Single Tuned Transformers for Transistor Amplifiers, by S. H. Colodny, Philco Corp.

Design Considerations for Transistorized Automobile Receivers, by R. A. Santilli, Radio Corp. of America.

Voltage Sensitivity of Local Oscillators, by Wen Yuan Pan, Radio Corp. of America.

SESSION 21
Tuesday, March 25
2:30-5:00 P.M. (C)

BEAM AND DISPLAY TUBES

High Transconductance Wideband Television Gun, by E. Atti, Westinghouse Electric Corp.

The Annular Geometry Electron Gun: A New Electron Device, by J. W. Schwartz. RCA Labs.

Recent Developments in Shaped Beam Display and Recording Techniques, by R. M. Peterson and R. C. Ritchart, Stromberg-Carlson Co.

"ELF," A New Electroluminescent Display, by E. A. Sack, Westinghouse Electric Corp.

A Tube that Tells Time, by W. T. Eriksen and E. J. Handly, Raytheon Manufacturing Co.

SESSION 22
Tuesday, March 25
2:30-5:00 P.M. (C)

BIOLOGICAL TRANSDUCERS—PANEL DISCUSSION

Chairman: Otto H. Schmitt, Dept. of Physics, University of Minnesota

SESSION 23
Tuesday, March 25
2:30-5:00 P.M. (C)

RELIABILITY THROUGH COMPONENTS

Reliability of Missile Guidance Systems, by A. R. Gray, The Martin Co.

Component Part Failure Rate Analysis for Prediction of Equipment Reliability, by R. L. Vander Hamm, Collins Radio Co.

A Progress Report on the ARMA Inertial Guidance System Reliability Program, by E. F. Dertinger, American Bosch Arma Corp.

An Impulse Test for Evaluating the Vi-

brational Characteristics of Receiving Tubes Over a Wide Frequency-Range, by S. A. Jolly and W. U. Shipley, General Electric Co.

Reliability of Power Amplifier Klystrons in Tropo-Scatter Communication Systems, by R. F. Lazzarini and H. A. Bailey, Eitel-McCullough, Inc.

SESSION 24
Tuesday, March 25
8:00-10:30 P.M. (WA)

ELECTRONICS IN SPACE—A PANEL DISCUSSION

Chairman: L. DuBridge, President California Institute of Technology

Propulsion and Interplanetary Travel, by Wernher von Braun and Ernest Stuhlinger, U. S. Army Ballistic Missile Agency, and Krafft A. Ehricke, Convair Astronautics Division.

Navigation and Control, by C. Stark Draper, MIT.

Man in the Space Environment, by D. G. Simons, USAF, Holloman Air Force Base.

Communications and Telemetering, by J. B. Wiesner, MIT.

Terminal Environment, by Fred L. Whipple, Smithsonian Astrophysical Observatory.

A Prelude to Space Travel—The round table panel of eight scientists will discuss informally the major problems to be encountered, including the use of electronics for propulsion, navigation, communications, telemetering and instrumentation.

SESSION 25
Tuesday, March 25
8:00-10:30 P.M. (C)

ELECTRONICS SYSTEMS IN INDUSTRY—A PANEL SYMPOSIUM

Chairman: J. D. Ryder, Dean, College of Engineering, Michigan State University

Participants:

J. M. Bridges, Office of the Assistant Secretary of Defense (Research and Engineering.

C. C. Hurd, International Business Machines Corp.

T. R. Jones, Daystrom, Inc.

J. D. Ryder, Michigan State University.

The great impact which electronics had on American industry will be highlighted at this panel symposium.

J. D. Ryder will act as Chairman and open the symposium with a paper on "New Trends in Engineering Education." The emphasis in Dean Ryder's talk will be on strengthening the requirements in fundamental sciences, without which neither the demands of industry nor those of our defense establishments can be satisfied.

C. C. Hurd will discuss new ideas which found their entry in industry in connection with fully automatic processes.

T. R. Jones will speak about organization of complete electronic systems, utilizing the resources of several integrated organizations.

J. M. Bridges will highlight the military aspects associated with electronic systems engineering and their relationship to the electronic engineering professional society.

SESSION 26
Wednesday, March 26
10:00 A.M.-12:30 P.M. (WA)

AERONAUTICAL AND NAVIGATIONAL ELECTRONICS

Airborne Dual Antenna System for Aerial Navigation, by W. M. Spanos and J. M. Ashbrook, Federal Telecommunication Labs.

Engineering Evaluation of an Automatic Ground Controlled Approach System (AN/

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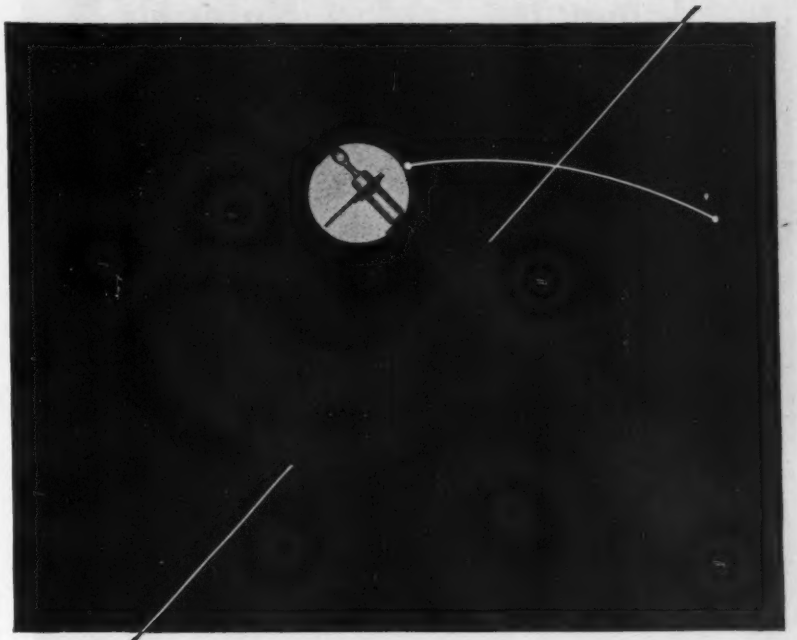

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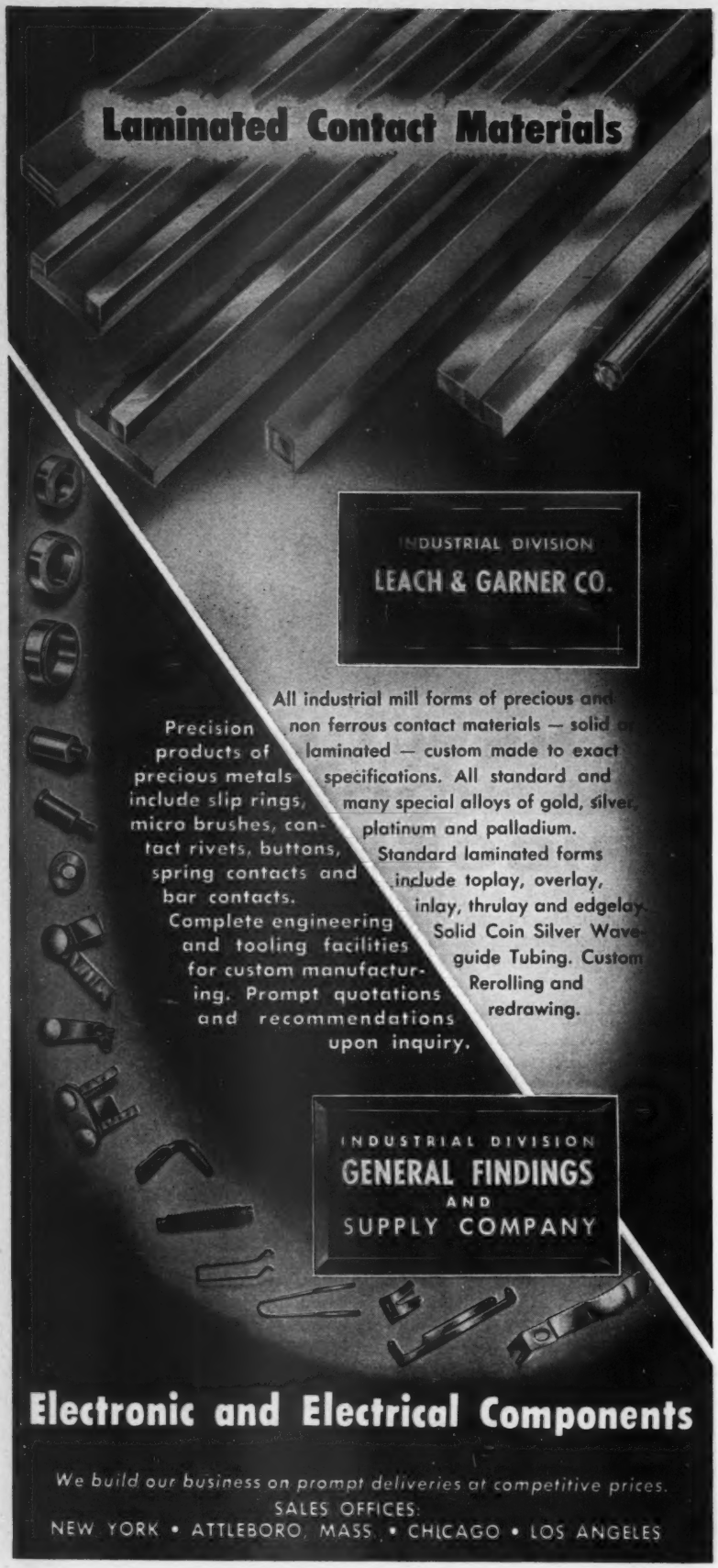
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MSN-3), by R. M. Brooks and W. F. Hoy, Rome Air Development Center, Griffiss Air Force Base.

A Quantitative Analysis of Automatic Target Detection-Position Estimation Schemes Observing Scintillating Targets in Noise, by C. M. Walter, Air Force Cambridge Research Center.

Applying the Amplitron and Stabilotron to MTI Radar Systems, by T. A. Weil, Raytheon Mfg. Co.

Transistorized Airborne Frequency Standard, by G. R. Hykes, Collins Radio Co.

SESSION 27
Wednesday, March 26
10:00 A.M.-12:30 P.M. (WA)

STATISTICAL APPLICATIONS

Frequency-Domain Statistical Model of Linear Variable Networks for Finite Operating Time, by G. W. Johnson, IBM.

The Root Square Locus Plot—A Geometrical Method for Synthesizing Optimum Servo Systems, by S. S. L. Chang, New York University.

TV Bandwidth Reduction by Digital Coding, by W. F. Schreiber and C. F. Knapp, Technicolor Corp.

Subjective Experiments in Visual Communication, by R. E. Graham, Bell Telephone Labs., Inc.

Demonstration of Some Visual Effects of Using Frame Storage in Television Transmission, by M. W. Baldwin, Jr., Bell Telephone Labs., Inc.

SESSION 28
Wednesday, March 26
10:00 A.M.-12:30 P.M. (WA)

ELECTRONIC COMPONENT PARTS

Development of Electronic Components for the Nuclear Radiation Environment, by J. W. Clark, Hughes Aircraft Co.

Design of Shielded Air-Cored Inductors, by R. O. Schildknecht, Federal Telecommunication Labs.

Ceramic Coating Applications in the Electrical Field, by P. Huppert, Gulton Industries, Inc.

The Components Engineer and The Sales Engineer, Partners in Reliability, by P. C. Knox, Lutherville, Md.

Miniature Ruggedized Precision Meters, by J. F. Faughnan and R. E. Loiselle, Signal Corps Engineering Labs.

SESSION 29
Wednesday, March 26
10:00 A.M.-12:30 P.M. (WA)

CIRCUIT THEORY I AND ULTRASONICS I: SYMPOSIUM ON "MODERN ASPECTS OF DELAY LINES"

Low-Dispersion Wired Delay Lines, by M. J. DiToro, Polytechnic Research & Dev. Co.

Electrical Design of the Transducer Networks of a Magnetostrictive Delay Line, by L. Rosenberg and A. Rothbart, Federal Telecommunication Labs.

The Approximation Problem in Lumped Delay Line, by A. Papoulis, Polytechnic Institute of Brooklyn.

Coiled Wire Torsional Wave Delay Line, by R. N. Thurston and L. M. Tornillo, Bell Telephone Labs., Inc.

Variable Delay Line Using Ultrasonic Surface Waves, by J. D. Ross, S. J. Kapuscienski and K. B. Daniels, E. I. duPont deNemours & Co.

SESSION 30
Wednesday, March 26
10:00 A.M.-12:00 NOON (WA)

THE CANADIAN AUTOMATION SYSTEM OF POSTAL OPERATIONS

The Canadian Automation System of

Postal Operations, by M. Levy, Canada Post Office Dept.

Organization of the Electronic Computer for the Canadian Electronic Mail Sorting System, by A. Barszczewski, Canada Post Office Dept.

Coding and Error Checking in the Canadian System, by M. Levy and V. Czorny, Canada Post Office Dept.

The Canadian Automation System of Postal Operations, by H. Jensen and K. H. Ullyatt, Canada Post Office Dept.

SESSION 31
Wednesday, March 26
10:00 A.M.-12:30 P.M. (C)
RADAR IN MILITARY ELECTRONICS

Automatic and Continuous Radar Performance Monitor, by W. C. Woods, Sperry Gyroscope Co.

Analysis and Theoretical Investigation of New Military Electronic Missile and Aircraft-Borne Equipment, by D. Ehrenpreis, New York, N. Y.

Packaged High Power Radar Transceivers, by H. N. C. Ellis-Robinson, Marconi's Wireless Telegraph Co., Ltd.

Limitations of the Output Pulse Shape of High Power Pulse Transformers, by R. G. deBuda and J. Vilcans, Canadian General Electric Co., Ltd.

A Radar Electronic Countermeasures Simulator, by L. Sternlicht, The Hallicrafters Co.

SESSION 32
Wednesday, March 26
10:00 A.M.-12:30 P.M. (C)
MICROWAVE MEASUREMENT

Power Limiting Using Ferrites, by R. F. Soohoo, Cascade Research Corp.

An Ultra-Precise Microwave Interferometer, by G. R. Blair, McMillan Laboratory, Inc.

Direct Reading Microwave Phase Meter, by H. A. Dropkin, Diamond Ordnance Fuze Labs.

A Microwave Spin Resonance Spectrometer, by R. R. Unterberger, California Research Corp.

A New Microwave Rotary Joint, by W. E. Fromm, E. G. Fubini, and H. S. Keen, Airborne Instruments Laboratory, Inc.

SESSION 33
Wednesday, March 26
10:00 A.M.-12:30 P.M. (C)
SEMICONDUCTOR DEVICES

A New Passive Semiconductor Component, by R. M. Warner, Jr., Bell Telephone Labs., Inc.

Use of the RCA 2N384 Drift Transistor as a Linear Amplifier, by D. M. Griswold and V. J. Cadra, Radio Corporation of America.

High Current Switching Times for a PNP Drift Transistor. Numerical Analysis on the I. B. M. 704 Digital Computer, by A. Mitchell, International Business Machines Corp., and L. Lapidus, Princeton University.

A New High-Frequency Diffused Base Transistor, by J. Sardella and R. Wonson, Raytheon Manufacturing Co.

A New Five Watt, Class A, Power Amplifier, by G. Freedman, J. Williams, P. Flaherty, D. Root, D. Spittlehouse, W. Waring, P. Kaufmann, P. Whoriskey, Raytheon Manufacturing Co.

SESSION 34
Wednesday, March 26
2:30-5:00 P.M. (WA)
RELIABILITY THROUGH SYSTEMS

Blocking-Oscillator Transformers
Set of Pulsite transformers gives pulse width from 0.1 to 10 microsec in NBS preferred circuit. Units meet MIL-T-27A, Grade 1, Class R. Design your pulse circuits quickly by simply plugging in unit with desired characteristic. Airpax kit of 8 oscillator units and 2 interstage units in handy plastic box from stock. Transformer Division, Baltimore 20, Maryland.
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Airpax magnetic power amplifiers control the current to both phases of split-phase motors. Standby power is thus greatly reduced and full torque is produced under load. Amplifiers are polarity sensitive. Airpax units for 6 or 10 watts per phase for 400-CPS motors are in stock at the Seminole Division, Fort Lauderdale, Florida.
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On an Analytical Design Technique, by J. B. Heyne, Hughes Aircraft Co.

Reliability or Life Performance, by A. R. Matthews, Wright Air Development Center, ARDC.

Reliability Improvement Through Redundancy at Various System Levels, by B. J. Flehinger, IBM Watson Lab.

Fundamental Techniques in Doppler Radar Navigation System Reliability Measurements, by P. D. Stahl, General Precision Lab., Inc.

Reliability Prediction and Test Results on USAF Ground Electronic Equipment, by E. Krzysiak and J. Naresky, Rome Air Development Center, ARDC, Griffiss Air Force Base.

SESSION 35
Wednesday, March 26
2:30-5:00 P.M. (WA)
INFORMATION THEORY: CODING AND DETECTION

On Communication Processes Involving Learning and Random Duration, by R. Bellman and R. Kalaba, The Rand Corp.

The Application of "Comparison of Experiments" to Detection Problems, by N. Abramson, Electronics Research Lab., Stanford University.

Signals with Uniform Ambiguity Functions, by R. M. Lerner, MIT, Lincoln Lab.

Evaluation of Some Error Correction Methods Applicable to Digital Data Transmission, by A. B. Brown and S. T. Meyers, Bell Telephone Labs., Inc.

Algebraic Decoding for the Binary Erasure Channel, by M. A. Epstein, Lincoln Lab., MIT.

SESSION 36
Wednesday, March 26
2:30-5:00 P.M. (WA)
ELECTRONIC COMPONENT PARTS

Effect of High Intensity Radiation on Electronic Parts and Materials, by C. P. Lascaro and A. L. Long, U. S. Army Signal Corps Engineering Labs.

Some Guideposts to the Use of Metallized Capacitors, by W. C. Lamphier, Sprague Electric Co.

New Amplifiers for Automatic Control of Active D-C Loads, by E. Levi, Microwave Research Institute.

Magnetostriction Transducers for Mechanical Filters, by R. L. Sharma and H. O. Lewis, Collins Radio Co.

Application of Piezoelectric Ceramic Resonators to Modern Band Pass Amplifiers, by A. Lungo and K. W. Henderson, Clevite Corp.

SESSION 37
Wednesday, March 26
2:30-5:00 P.M. (WA)
COMPUTERS AND CONTROL

A Preventive Maintenance Program for Large General Purpose Electronic Analog Computers, by R. P. Sykes, The Ramo-Wooldridge Corp.

The TRICE—A High Speed Incremental Computer, by S. Ruhman and J. M. Mitchell, Packard-Bell Computer Corp.

Digital Moon Radar Antenna Programmer with Analog Interpolator Servo, by O. A. Guzmann, U. S. Army Signal Corps Engineering Labs.

A Balanced Precision Reference Regulator for Computer Application, by D. A. Noden, The Martin Co.

A Solid State Analog-to-Digital Conversion Device, by M. Palevsky, Packard-Bell Computer Corp.

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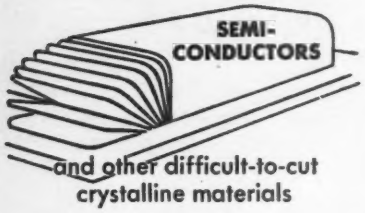

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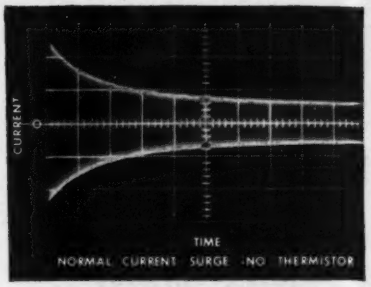

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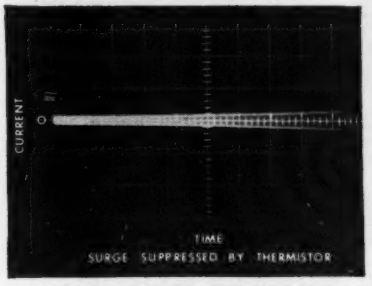

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Application of voltage to tubes in receivers, transmitters, computers, and other electronic equipment subjects their filaments to initial current surges (top oscillogram).

These surges cause premature failure or unsatisfactory service life. Bottom oscillogram shows how a G-E thermistor can suppress the surge and protect the tube filaments.

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SESSION 38
Wednesday, March 26
2:30-5:00 P.M. (C)

INSTRUMENTATION SYSTEMS

An Earth Satellite Instrumentation for Cloud Measurement, by R. Hanel and R. A. Stampfl, U. S. Army Signal Engineering Labs.

A Precise Optical and Radar Tracking Range, by E. V. Kullman, Rome Air Development Center (RCEMI).

A High Speed Radar Signal Measurement and Recording System, by A. Nirenberg and R. Burfiend, Airborne Instruments Lab., Inc.; M. Baller, Cambridge Research Dev. Center, and A. Wight, Laboratory for Electronics, Inc.

A High Performance Multi-Channel Instrumentation System, by W. G. Wolber, Bendix Aviation Corp.

Instrumentation Dynamically Analyzed for Optimum Reliability, Weight and Geometric Space Envelope Subjected to Severe Vibrations and Shock, by David Ehrenpreis, New York, N. Y.

SESSION 39
Wednesday, March 26
2:30-5:00 P.M. (C)

MICROWAVE COMPONENTS

Yttrium Garnet UHF Isolator and Reciprocal Phase Shifter, by F. R. Morgenthaler, USAF and D. L. Fye, Air Force Cambridge Research Center.

High Power, Broadband, Microwave Gas Discharge Switch Tube, by S. J. Tetenbaum and R. M. Hill, Sylvania Electric Products Inc.

High Power Microwave Filters, by J. H. Vogelman, Rome Air Development Center.

A Band Separation Filter for the 225-400 MCS Band, by A. I. Grayzel, Lincoln Laboratory, MIT.

Direct-Coupled, Band-Pass Filters with $\lambda/4$ Resonators, by G. L. Matthaei, The Ramo-Wooldridge Corp.

SESSION 40
Wednesday, March 26
2:30-5:00 P.M. (C)

PROPAGATION AND ANTENNAS I—GENERAL

Extreme Useful Range of VHF Transmission by Scattering From the Lower Ionosphere, by R. C. Kirby, National Bureau of Standards.

Meteor Trail Propagation, by J. T. de-Bettencourt and Albert Ward, Pickard & Burns; and Bernard Goldberg, U. S. Army Signal Engineering Labs.

The Duty Cycle Associated with Forward-Scattered Echoes from Meteor Trails, by H. J. Wirth and T. J. Keary, U. S. Navy Electronics Lab.

A New Low Frequency Antenna, by E. W. Seeley and J. D. Burns, U. S. Naval Ordnance Lab.

Logarithmically Periodic Antenna Designs, by R. H. DuHamel and F. R. Ore, Collins Radio Co.

Phase Center of Helical Beam Antennas, by Seymour Sander, RCA; and D. K. Cheng, Syracuse University.

SESSION 41
Thursday, March 27
10:00 A.M.-12:30 P.M. (WA)

MAGNETICS AND COMPUTERS

A High Speed n-pole, n-position Magnetic Core Matrix Switch, by A. L. Lane and A. Turczyn, Technitrol Engineering Co.

Apertured Plate Memory: Operation and Analysis, by W. J. Haneman and J. Lehmann, RCA Labs; and C. S. Warren, RCA, Defense Electronic Products.

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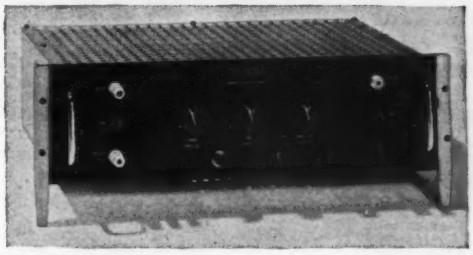

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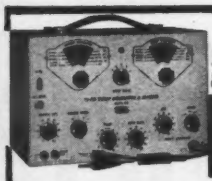

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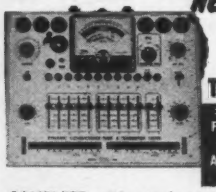

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Calculation of Flux Patterns in Ferrite Multipath Core Structures, by S. A. Abbas and D. L. Critchlow, IBM.

Logic by Ordered Flux Changes in Multipath Ferrite Cores, by N. F. Lockhart, IBM.

Flux Responsive Magnetic Heads for Low Speed Read-Out of Data, by L. W. Ferber, Clevite Corp.

SESSION 42
Thursday, March 27
10:00 A.M.-12:30 P.M. (WA)

CIRCUIT THEORY II—UNUSUAL ASPECTS OF FILTER DESIGN

Multichannel-Filter Synthesis in Terms of Dipole Potential Analog, by H. A. Wheeler, Wheeler Labs.

Minimum Insertion Loss Filters, by E. G. Fubini, Airborne Instruments Lab., Inc., and E. A. Guillemin, MIT.

A New Approach to the Design of High Frequency Crystal Filters, by R. A. Sykes, Bell Telephone Labs., Inc.

Synthesis of Active RC Single-tuned Bandpass Filters, by J. J. Bongiorno, Microwave Research Inst.

A New Class of Filters, by A. Papoulis, Polytechnic Institute of Brooklyn.

SESSION 43
Thursday, March 27
10:00 A.M.-12:30 P.M. (WA)

ULTRASONICS II—DELAY LINE MEASUREMENTS

Measurements of Delay in Ultrasonic Systems, by D. L. Arenberg, Arenberg Ultrasonic Laboratory, Inc.

Precise Measurement of Time Delay, by J. E. May, Jr., Bell Telephone Labs., Inc.

The Measurement of Delay-Line Transducer Resistance, by J. J. G. McCue, Lincoln Lab., MIT, and J. A. Leavitt, Harvard University.

Ultrasonic-Delay-Line Terminating Circuits and Passband Measurements, by M. Axelbank, Lincoln Lab., MIT.

Measurement of Temperature and Frequency Dependence of Insertion Loss in Delay Lines, by A. H. Meitzler, Bell Telephone Laboratories, Inc.

The Measurement of the Total Spurious Responses of an Ultrasonic Delay Line, by M. S. Zimmerman, General Atronics Corp.

SESSION 44
Thursday, March 27
10:00 A.M.-12:30 P.M. (WA)

INDUSTRIAL ELECTRONICS

Distributor Test Stand, by J. A. Lovell, Airborne Instruments Lab., Inc.

A Digital Setting System for an X-Ray Thickness Gage, by V. A. Blumhagen, General Electric Co.

Application of Magnetic Core Logic to Industrial Controls, by H. Tellefson and S. Alessio, Panellit, Inc.

A Coordinated System of Automatic Controls, by R. R. Batcher, Douglaston, N. Y.

SESSION 45
Thursday, March 27
10:00 A.M.-12:00 Noon (WA)

ASPECTS OF RF INTERFERENCE IN MILITARY ELECTRONIC AND COMMUNICATIONS SYSTEMS

Treatment and Methods for the Reduction of Pulse and Random Interference, by P. M. Creutz, Packard-Bell Electronics Corp.

Reduction of Bandwidth Requirements for Radio Relay Systems, by D. L. Jacoby and R. H. Levine, U. S. Army Signal Engineering Labs., and Alfred Mack and Alan Meyerhoff, Radio Corporation of America.

Analysis of the Spectral Shape of Mod-

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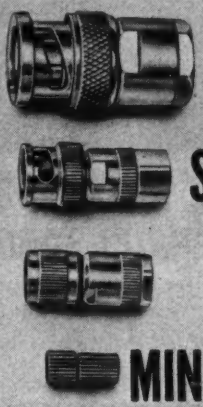

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Near-Zone Power Transmission Formulas, by Ming-Kuei Hu, Syracuse University.

SESSION 46
Thursday, March 27
10:00 A.M.-12:30 P.M. (C)

DATA REDUCTION AND RECORDING

Instrumentation for Recording and Analysis of Audio and Sub-Audio Noise, by D. D. Howard, Naval Research Lab.

A Xerographic Cathode Ray-Tube Recorder, by H. H. Hunter, O. A. Ullrich and L. E. Walkup, Battelle Memorial Inst.

Theory of Magnetography, by S. J. Begun, Clevite Research Center.

Applications of Magnetography to Graphic Recording, by J. B. Gehman, Clevite Research Center.

A Shaft Position Digitizer System of High Precision, by L. G. deBey, Ballistic Meas. Lab., Aberdeen Proving Ground; and R. C. Webb, Colorado Research Corp.

A High Precision Digital Shaft Position Indicator, by D. H. Raudenbush, Telecomputing Corp.

SESSION 47
Thursday, March 27
10:00 A.M.-12:30 P.M. (C)

ANTENNAS II—GENERAL

Early Warning Radar Antennas, by J. M. Flaherty and Eugene Kadak, Westinghouse Electric Corp.

Phase and Amplitude Measurements in the Near Field of Microwave Lenses, by C. W. Morrow, P. E. Taylor, and H. T. Ward, Melpar, Inc.

Annular Slot Direction Finding Antenna, by H. M. Hougardy and Nicholas Yaru, Hughes Aircraft Co.

A Novel Antenna for Mobile Radio Relay Operation in the UHF Range, by F. J. Triolo, U. S. Army Signal Engineering Labs.

Lightweight, High Gain Antenna, by R. G. Malech, Airborne Instruments Lab., Inc.

Voltage Breakdown Characteristics of Microwave Antennas, by J. B. Chown, T. Morita, and W. E. Scharfman, Stanford Research Institute.

SESSION 48
Thursday, March 27
10:00 A. M.-12:30 P.M. (C)

MICROWAVE TUBES

Noise Characteristics of a Backward-Wave Oscillator, by J. B. Cicchetti and J. Munushian, Hughes Research and Development Labs.

The Pulsed M-Type Backward Wave Oscillator and Its Modes of Operation, by Gerald Klein and A. L. Winters, U. S. Army Signal Engineering Labs.

The ESTIATRON—An Electrostatically Focused Medium-Power Traveling-Wave Amplifier, by D. J. Blattner and F. E. Vaccaro, Radio Corporation of America.

The Generation of Shaped Pulses Using Microwave Klystrons, by D. H. Preist, Eitel-McCullough, Inc.

Wide-Band UHF 10 KW Klystron Amplifier, by H. Goldman, L. F. Gray, L. Pollack, Federal Telecommunication Labs.

SESSION 49
Thursday, March 27
2:30-5:00 P.M. (WA)

GENERAL SYSTEMS

Combat Computers, by W. F. Luebbert, U. S. Army Signal Corps Engineering Labs.

The USAF Automatic Language Translator, Mark I, by G. A. Shiner, Rome Air Development Center.

Non-Binary Switching Theory, by O. Lowenschuss, Sperry Gyroscope Co.

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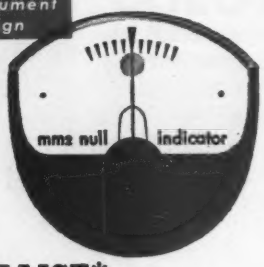

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High Speed Character Sensing Equipment, by A. I. Tersoff, Intelligent Machines Research Corp.

Minimum Time Programming on a Drum Computer, by B. Shiffman, The Ramo-Wooldridge Corp.

SESSION 50
Thursday, March 27
2:30-5:00 P.M. (WA)

CIRCUIT THEORY III—APPLICATION OF TOPOLOGICAL AND GROUP CONCEPTS

Signal Flowgraph and Network Topology, by Omar Wing, Columbia University.

New Transpositions in Power Transformer Windings, by R. G. deBuda, Canadian General Electric Co., Ltd.

Two-Terminal Pair Symmetry Relations, by R. C. Kiessling, Lenkurt Electric Co.

Analysis of Nonreciprocal Networks by Digital Computer, by Wataru Mayeda and M. E. Van Valkenburg, University of Illinois.

On Non-Series-Parallel Realization of Driving-Point Function, by Wan H. Kim, Columbia University.

SESSION 51
Thursday, March 27
2:30-5:00 P.M. (WA)

ULTRASONICS III—MEASUREMENT OF RADIATED ACOUSTIC POWER

Power Handling Capability of Ferroelectric Ceramics, by G. W. Renner, R. A. Plante and T. F. Hueter, Raytheon Manufacturing Co.

Measurement of Acoustic Power Radiated from Underwater Sound Transducers, by R. J. Bobber, Office of Naval Research.

An Instrument for Determining Intensity of Ultrasound, by J. F. Herrick, B. H. Anderson and M. Neher, Mayo Clinic and Mayo Foundation.

Measurements of Acoustic Power in Industrial Ultrasonic Equipment, by W. Welkowitz, Gulton Industries, Inc.

Panel Discussion—Problems in Power Measurement

Panel Members G. E. Henry, General Electric Eng. Lab; S. E. Jacke, Detrex Corp; Frank Massa, Massa Labs., Inc; Murray Strasberg, David Taylor Model Basin.

SESSION 52
Thursday, March 27
2:30-5:00 P.M. (WA)

LONG DISTANCE COMMUNICATIONS

Single Channel Radioteletype Communication, by H. B. Voelcker, Jr., U. S. Army Signal Engineering Labs.

A World-Wide High Frequency SSB Radio Network, by Everett Bray, Collins Radio Co.

Comparison of Multi-Channel Radioteletype Systems Over a 5,000-Mile Ionospheric Path, by A. T. Brennan, Stromberg-Carlson Co; Bernard Goldberg and Arthur Eckstein, U. S. Army Signal Engineering Labs.

Basic Analysis on Controlled Carrier Operation of Tropospheric Scatter Communication Systems, by L. P. Yeh, Westinghouse Electric Corp.

Transportable Tropospheric Scatter Communications Systems, by A. J. Svien, Collins Radio Co.; and J. C. Domingue, Signal Communications Dept.

Evaluation of IF and Baseband Diversity Combining Receivers, by R. T. Adams and B. M. Mindes, Federal Telecommunications Labs.

Transmission of Digital Data over Multi-Hop Tropospheric, by C. N. Lawrence and

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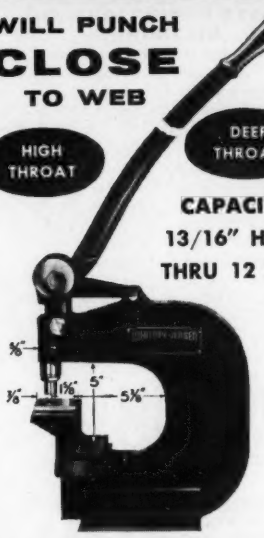

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SESSION 53
Thursday, March 27
2:30-5:00 P.M. (C)

HIGH ACCURACY INSTRUMENTS, MEASUREMENT AND CALIBRATION

A Feedback Amplifier with Negative Output Resistance for Magnetic Measurements, by W. P. Harris and I. L. Cooter, National Bureau of Standards.

Millimicrosecond, Wide-Aperture, Electro-optical Shutter, by J. A. Hull, Avco Mfg. Corp.

A Quartz Servo Oscillator, by Norman Lea, Marconi's Wireless TelegraphCo., Ltd.

A New Method to Simplify Bridge Type Measurements on Quartz Crystal Units, by Erich Hafner, U. S. Army Signal Engineering Labs.

RF Voltage Calibration Consoles, by M. C. Selby, L. F. Behrent and F. X. Ries, National Bureau of Standards.

SESSION 54
Thursday, March 27
2:30-5:00 P.M. (C)

ANTENNAS III—MICROWAVE ANTENNAS

A Compact Dual-Purpose S-Band Beacon and VHF Telemetry Antenna, by W. O. Puro, W. G. Scott and W. A. Meyer, Melpar, Inc.

A Volumetric Electrically Scanned Two-Dimensional Microwave Antenna Array, by J. L. Spradley, Hughes Aircraft Co.

Closely Spaced Polyrod Arrays, by L. W. Mickey, G. G. Chadwick, Melpar, Inc.

Wave Guide Loaded Surface Wave Antenna, by R. F. Hyneman and R. W. Hougardy, Hughes Aircraft Co.

Dielectric Image Line Surface Wave Antenna, by H. W. Cooper, Murray Hoffman and Sheldon Isaacson, Maryland Electronic Mfg. Corp.

A Dual Beam Planar Antenna for Janus Type Doppler Navigation Systems, by H. Saltzman and G. Stavis, General Precision Lab., Inc.

SESSION 55
Thursday, March 27
2:30-5:00 P.M. (C)

RADIO & TELEVISION

Design Problems in Transformerless Single Rectifier TV Receivers, by D. Sillman, Westinghouse Electric Corp.

Problems in Two Dimensional Television Systems, by R. M. Bowie, Sylvania Electric Products, Inc.

A New High-Power Horizontal-Output Tube Deflection System for Color Television, by J. P. Wolff, and R. G. Rauth, Radio Corp. or America.

Improvements in Deflection Amplifier Design, by C. Droppa, Sylvania Electric Products, Inc.

AGC Design Considerations for TV Receivers, by R. H. Overdeer, Philco Corp.

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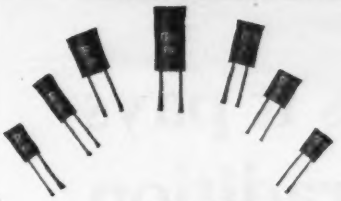

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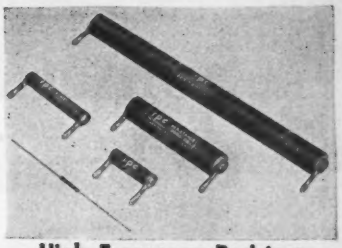

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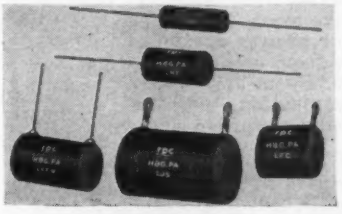

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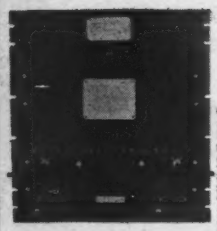

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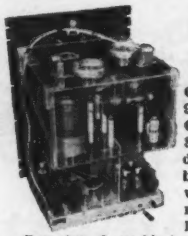

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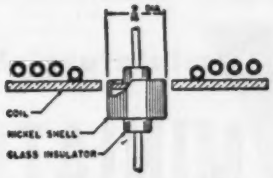

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General arrangement for pulling single crystals. Induction heating coil is shown surrounding quartz tube containing crucible with molten germanium in suitable atmosphere.

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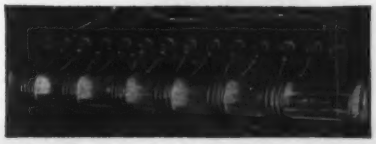

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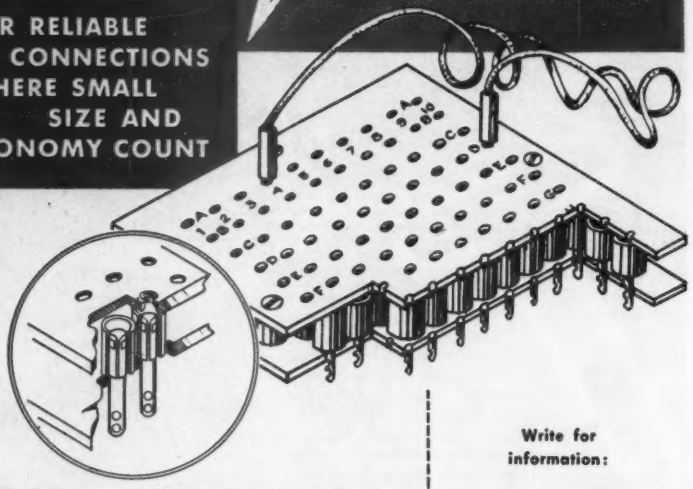

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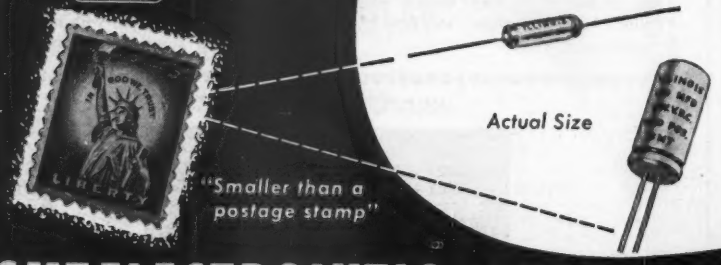

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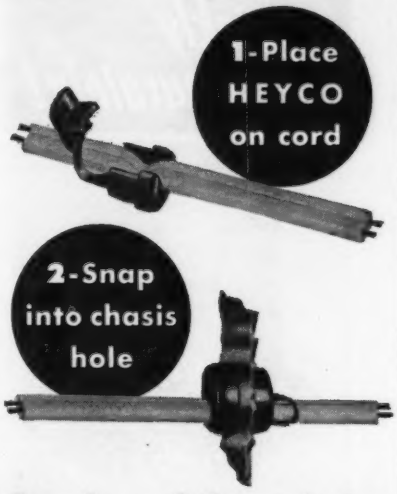

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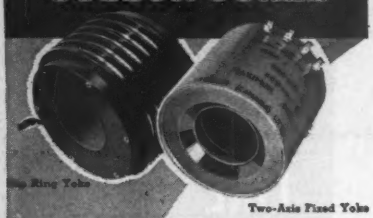

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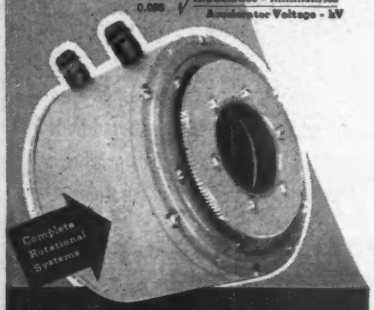

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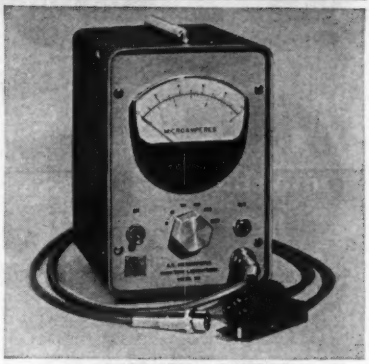

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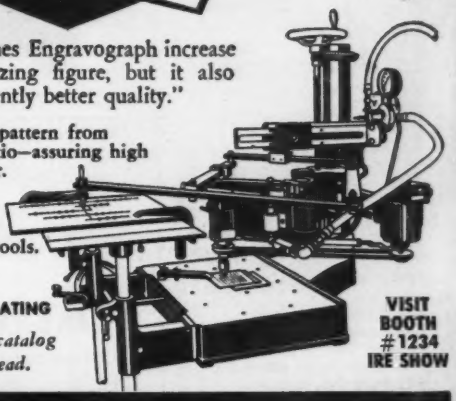

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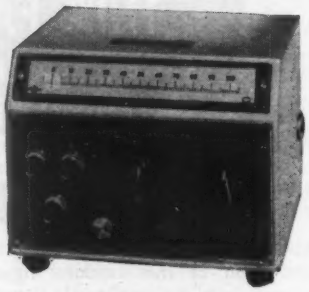

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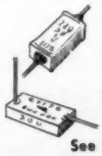

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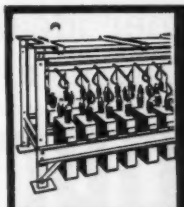

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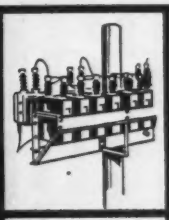

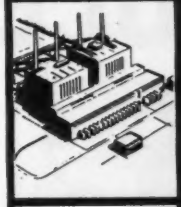

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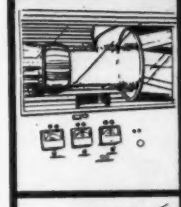

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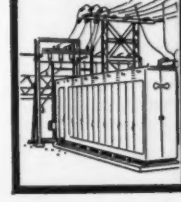

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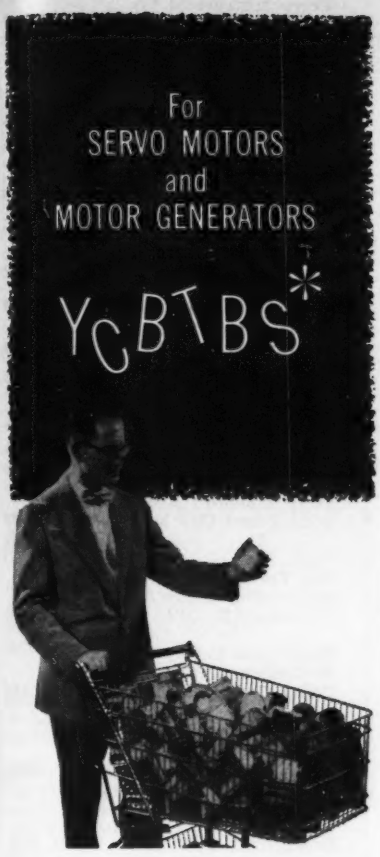

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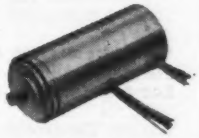

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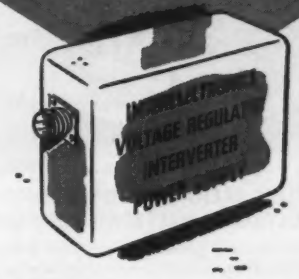

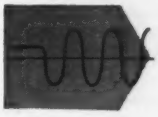

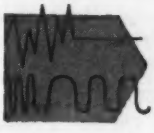

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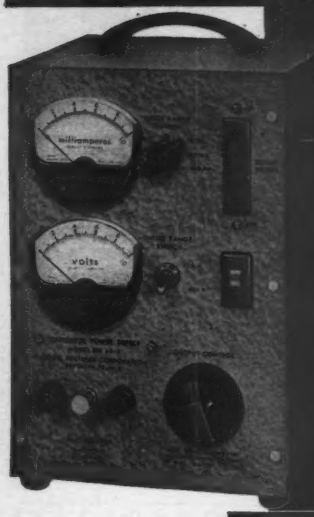

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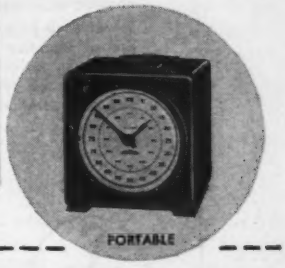

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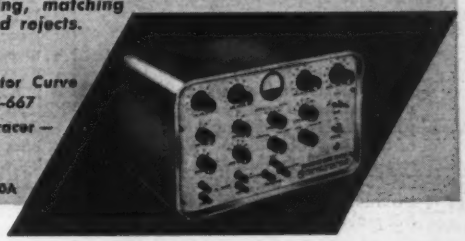

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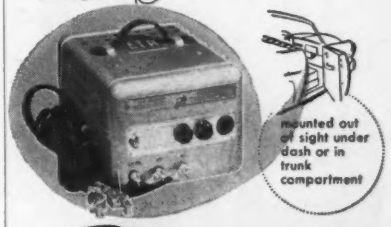

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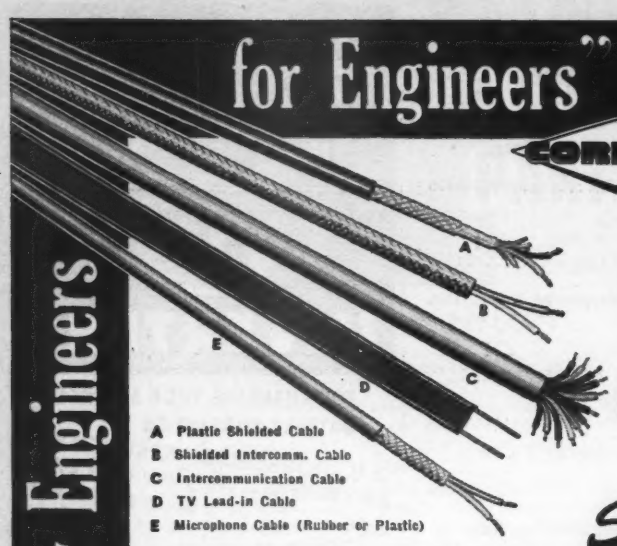

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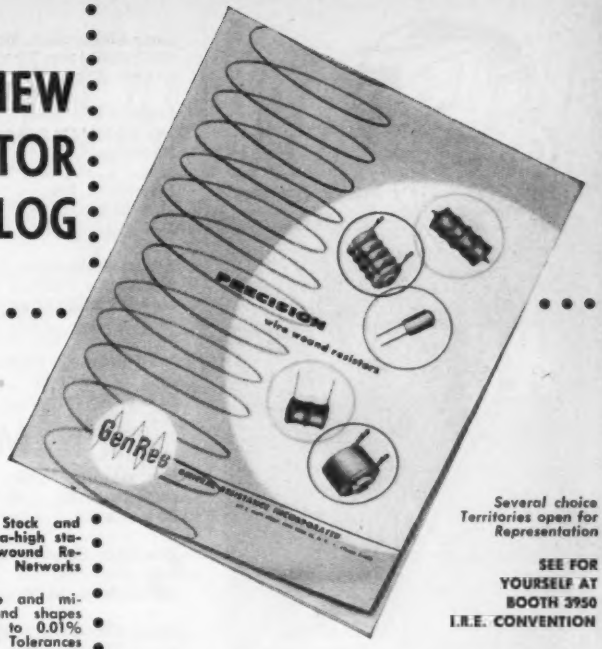

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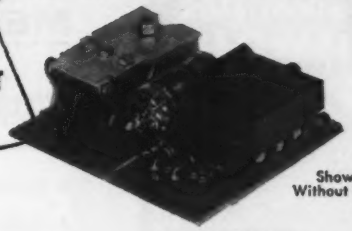

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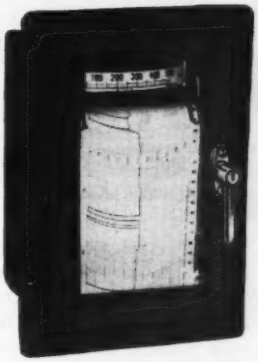

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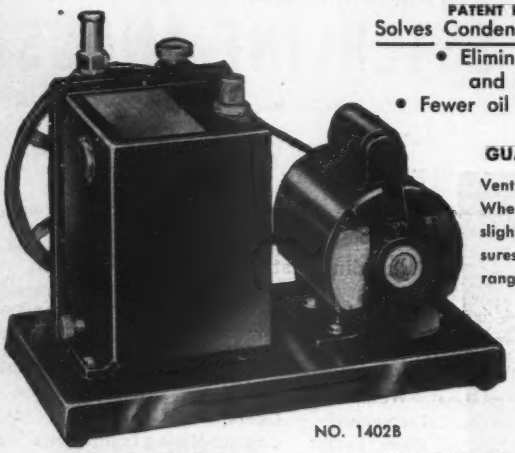

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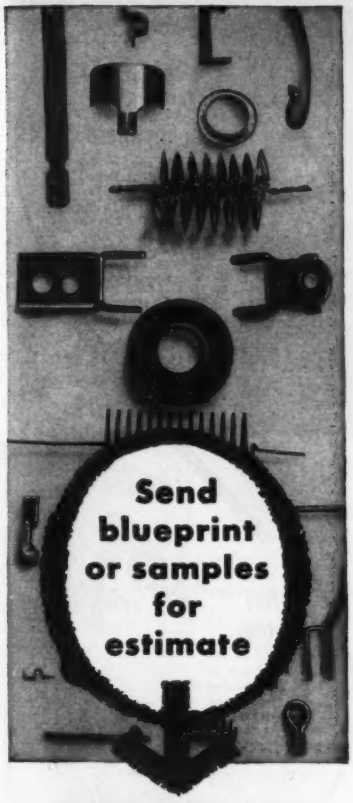

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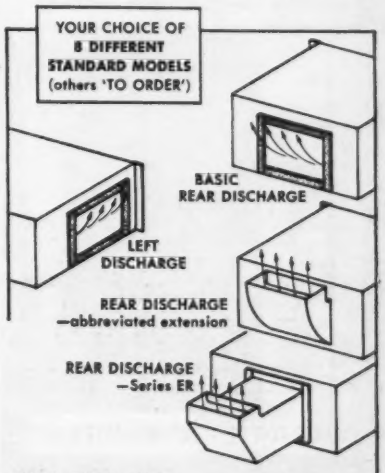
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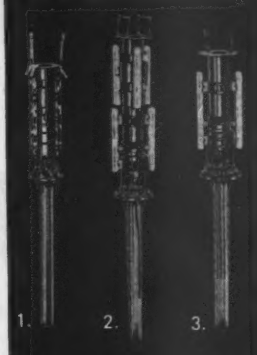

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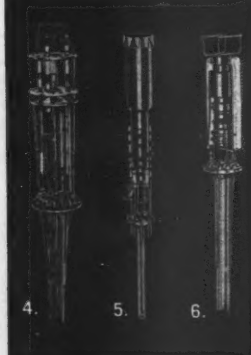

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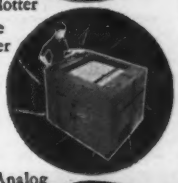

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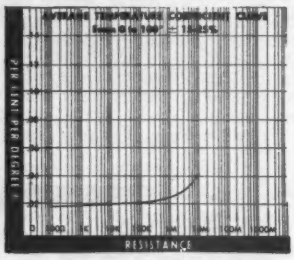
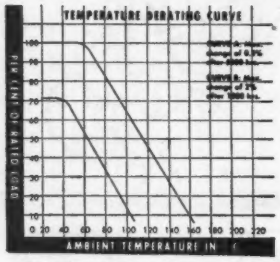


Temperature coefficient characteristics for ALPT—1 watt resistor



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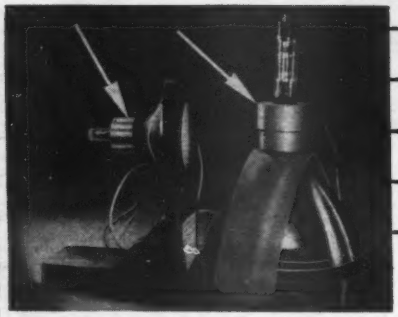

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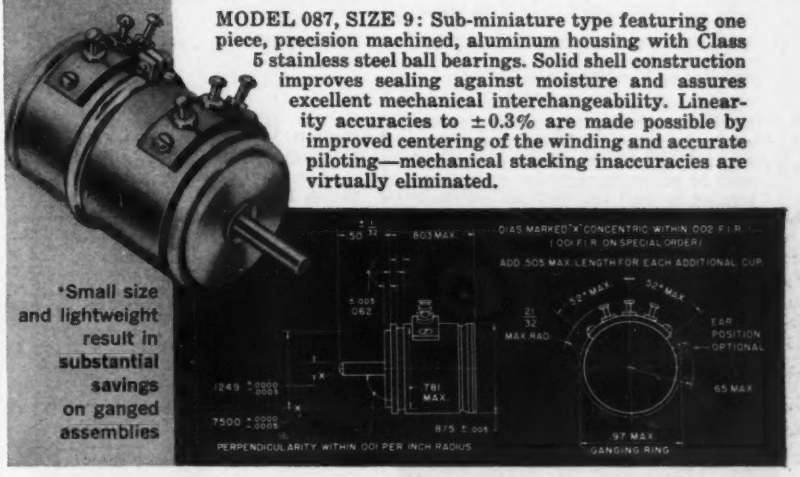

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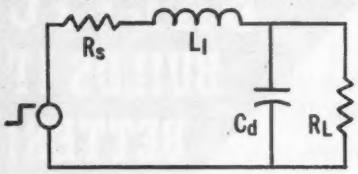

Where R_s is the internal resistance of the pulse source, R_L load resistance, L_l and C_d, leakage inductance and distributed capacitance, respectively. If the transformer is matched ($R_S=N^2R_L$), this circuit is valid for step-up and step-down transformers.

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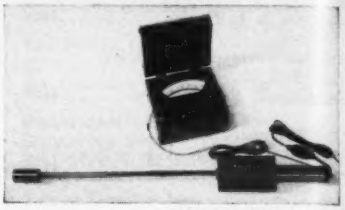

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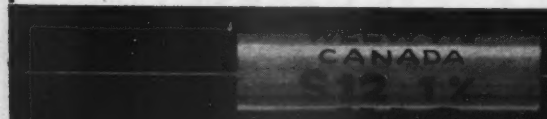

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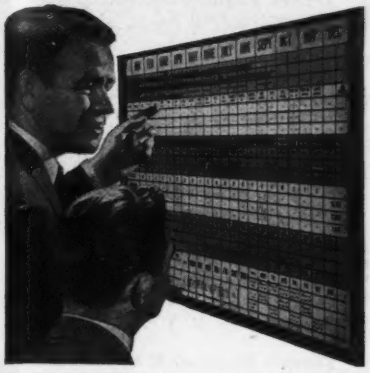

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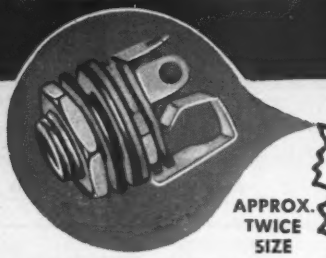

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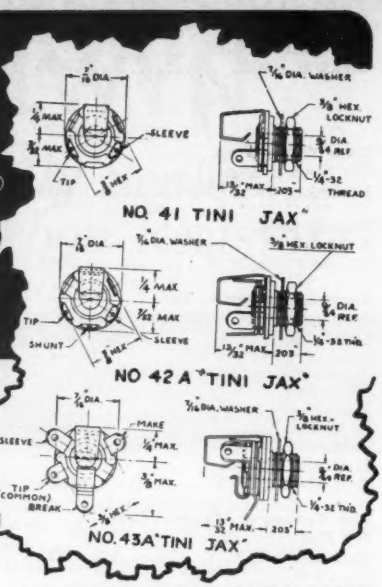

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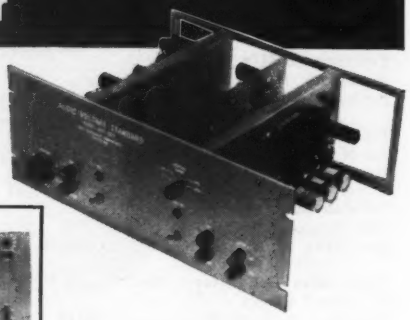

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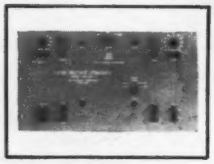

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51	.055	120	51			51-S
52	.055	150	52	52-C	52-A	52-S
53	.040	180	53	53-C	53-A	53-S
54	.030	200	54	54-C	54-A	54-S
54-H	.025	200	54-H		54-HA	
55	.018	200	55	55-C	55-A	
60	.015	200	60	66-C		
66	.012	200		66-C	66-A	
01	2-32	180	01			01-S
56	3-32	180	56	*56-C		*56-S
*57	4-32	180	*57			*57-S
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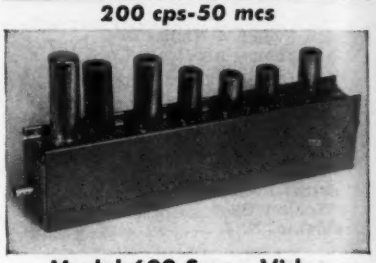

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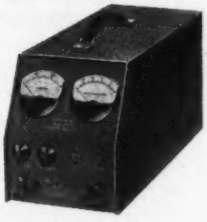

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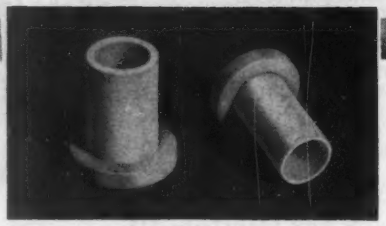

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NEW BOOKS

Propagation des Ondes Electromagnetiques de Haute Frequence

By J. Ortusi.
Societe Francaise De Documentation Electronique, Paris, 1957, 320 p, 3,100 fr.

This book is the second of a French scientific series entitled "Collection des Annale de Radioelectricite" edited by M. Ponte. It deals with the subject of high-frequency electromagnetic wave propagation.

The author has confined himself to three areas of current interests, each covered by a separate chapter. These three areas are wave propagation in anisotropic media, multiple terminal waveguides and wave propagation around the earth.

Two other chapters deal primarily in basic background materials for these specialized topics. The first is a brief treatment in Maxwell's equations and energy relationship. The second chapter deals with mathematics involved in propagating waves. Most of these introductory materials can of course be found in ordinary text books, but they are useful for reference and guidance in the notations used by the author for subsequent development.

Major Areas—The high-frequency wave-propagation field consists of mainly two major areas, namely one in dealing with the waveguide components with which the energy is directed and transformed in the equipment and the other in dealing with the electromagnetic wave propagation in the space after radiated from the antenna. In these two areas, two major new developments occurred in the last few years. In the component field, the introduction of anisotropic media such as ferrites not only offers challenging problems for theoreticians, but also offers a great deal of opportunity for engineers to make entirely new microwave devices such as circulators, isolators and other nonreciprocal devices. Since these are new developments, it is useful to have such a summary of the basic theories involving anisotropic medium which now appears only in scattered literatures. The

multiple terminal waveguide components that can be built with or without ferrites are discussed more in terms of physical principles rather than in detailed mathematics.

In the space wave propagation field, the rapid development in the last few years has been the theoretical and experimental understanding scattering wave propagation which puts the beyond-the-line-of-sight propagation for microwaves on a systematic engineering basis. The author has assembled a number of nomograms and charts which will help engineers in the design and selection of power requirements, antenna gain, etc., for a given signal-to-noise reception between different distances around the earth and with various terrain conditions.

This book should be a useful reference for those who are engaged in the studies of microwaves propagation and as an introductory to those who would like to learn more about the latest developments in this field.—C. C. Wang, *Sperry Gyroscope Co., Division of Sperry Rand Corp., Great Neck, N. Y.*

THUMBNAIL REVIEWS

The Science of Engineering Materials. Edited by J. E. Goldman, John Wiley & Sons, New York, 1957, 517 p, $12.00. An outgrowth of a series of studies and conferences on the introduction of solid-state physics and chemistry into engineering education, this book will be of interest to persons entering work in surfaces, dielectrics, strength of materials, magnetism, semiconductors and amorphous materials.

The Index of Technical Articles. Iota Services Ltd., 38 Farrington St., London, E.C. 4, England. Monthly index of articles appearing in scientific, industrial, technical and trade journals published in Great Britain. Entries are in modified form of Universal Decimal Classification System and consist of title and author of article and name, volume, number and date of periodical. Prices are 6 months, 3 guineas; 1 year, 6 guineas and single copy 10/6.

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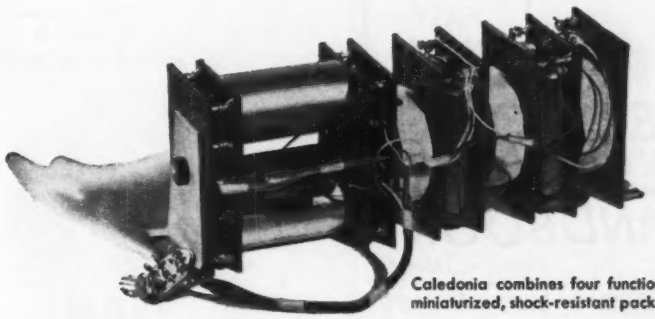

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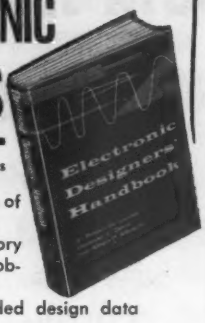

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COMMENT

Classroom Tv

In omitting the name of General Precision Laboratory (GPL) from "Classroom Tv Makes Grade" (Jan. 24, p. 19), you are giving less than a fair picture of those organizations contributing to the field. In view of your publication's high standards of accuracy in reporting on the electronics field, we trust you will bring these facts to the attention of your readers.

General Precision Laboratory has been active in the educational tv market for several years. Its broadcast and closed-circuit tv equipment is in use in 40 schools, colleges and other institutions throughout the country. Further, GPL is the outstanding developer of large-screen projection tv systems. In addition to their use for group communications and information display, these portable systems are currently aiding in instructing students in closed-circuit and off-the-air applications.

In the area of video recording, 19 of the 32 educational tv stations on or scheduled to be on the air have GPL recorders and a number of others are expected to acquire these systems.

STEWART PARDEE
GENERAL PRECISION LABORATORY
PLEASANTVILLE, N. Y.

A List of -Istors

("Fast Cryogenic Memories Bow," Oct. 1 '57, p 8) reports a new electronic component, the persistor. Present terminology of -istor components is continually growing into an intriguing list. To keep a finger on the pulse of all that is happening in electronics is an arduous task indeed. The rapid advancement of research, design and development is outpacing the ability of the individual design engineer to catch up with all that is new.

This list of -istor components may stir the curiosity of some who may not be familiar with all the names.

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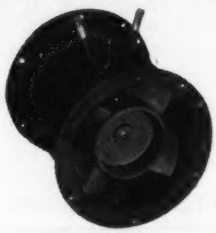

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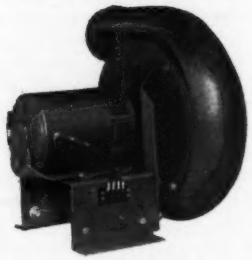

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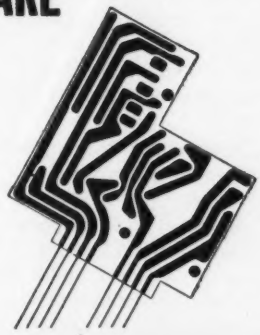

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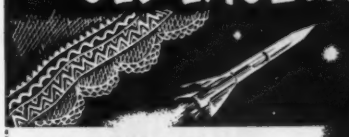

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